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Ridley, H.N. (1930). *The Dispersal of Plants Throughout the World.* Ashford, U.K.: L. Reeve.
Smith, A.C. & Darwin, S.P. (1988). Rubiaceae. In: Smith, A.C. (ed) *Flora Viliensis Nova, A New Flora of Fiji* 4: 143–193.
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Front cover picture: *Hanguana rubinea* (Photo by Jana Leong-Škorničková)

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Hanguana in Singapore demystified: an overview with descriptions of three new species and a new record

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ABSTRACT. The genus *Hanguana* (Hanguanaceae – Commelinales) was until recently believed to be represented in Singapore by a single species, *Hanguana malayana*. Recent extensive surveys, coupled with the detailed study of fresh and herbarium material, however, suggests the presence of six species. In addition to the recently described *Hanguana neglecta*, three additional species, *H. corneri*, *H. rubinea* and *H. triangulata*, are described here as new to science. Of the three newly described species, *Hanguana rubinea* and *H. triangulata* are native, while *H. corneri* is believed to have been introduced from Peninsular Malaysia to Singapore and planted in Bukit Timah Nature Reserve in the 1930s. *Hanguana nitens* is recorded for the first time from Singapore and is also certainly native. While a large helophytic species of *Hanguana*, currently interpreted to be *Hanguana malayana*, is cultivated as an ornamental plant in Singapore, no native populations have been observed by us in the wild and neither do any herbarium records exist to suggest that this species was ever native to Singapore. Colour plates and a key to all *Hanguana* species are provided. Notes on habitats and preliminary IUCN assessments are also included for all native species to better facilitate conservation efforts of Hanguanaceae in Singapore. The existence and taxonomic potential of scale structures sheathing the inner staminodes in female flowers, named here as staminodial scales, are highlighted here for the first time. The importance of seed characters is also discussed.

Keywords. Bukit Timah Nature Reserve, Central Catchment Nature Reserve, *Hanguana corneri, H. malayana, H. neglecta, H. nitens, H. rubinea, H. triangulata*, seeds, staminodial scales

Introduction

Hanguanaceae (Commelinales) is a small monogeneric family distributed in S and SE Asia, with the highest diversity in the Sunda region. The family is perhaps the most understudied family of monocots (Siti Nurfazilah et al., 2011), deserving much closer attention in the region. Currently 11 species are recognised of which eight were described in the last five years (Siti Nurfazilah et al., 2010, 2011; Mohd Fahmi et al., 2012; Niissalo et al., 2014). We, however, estimate that the number of species is likely to exceed 50 as future exploration and detailed studies, particularly of mature fruiting material, progress.

While Singapore has the best-known flora in SE Asia owing to the small size of the country, coupled with long-term botanical exploration (Niissalo et al., 2014), the state of knowledge is still far from complete. Numerous new records (e.g., Low et al., 2014; Rodda et al., 2012), as well as descriptions of new taxa (Sugumaran & Wong, 2014; Leong-Škorničková et al., 2014), including *Hanguana neglecta* (Niissalo et al., 2014), have recently been published from Singapore.

All existing herbarium records of *Hanguana* at SING, collected in Singapore between 1885 and 2009 (but excluding our recent collections) and amounting to 20 specimens in all, were previously misidentified as *Hanguana malayana* (Jack.) Merr., a name much misapplied across Asia. As such, *Hanguana malayana* is the only species listed in works dealing with the Singapore flora (Keng et al., 1998; Chong et al., 2009). During extensive fieldwork since 2010 by the first author, it was observed that several *Hanguana* species are present in Singapore's forests rather than just the single species previously suggested. Further fieldwork, coupled with the expertise of the second author who has been working on the Hanguanaceae of the Sunda region since 2010, revealed that at least six species are present in Singapore, although only four are considered native. These include *Hanguana neglecta* recently described from Singapore (Niissalo et al., 2014), *H. nitens* a species recently described from Johor, Peninsular Malaysia (Siti Nurfazilah et al., 2010), and two new species described below as *H. rubinea* and *H. triangulata*. There is no confirmed record of *Hanguana malayana* from the wild, be it by direct observation, or through the existence of even a single herbarium specimen from Singapore. *Hanguana corneri*, while described here as new to science, has been introduced to Bukit Timah Nature Reserve, and is not considered a Singaporean native.

The difficulty of studying species of *Hanguana* from herbarium material alone, and the importance of infructescence structure, stigma, fruits, seeds and indumentum for delimitation of taxa, has been highlighted before by Siti Nurfazilah et al. (2010, 2011). The importance of the morphology of the stigma cannot be overstated as it preserves well in herbarium material. The position of the stigma in relation to fruit, however, still requires further study. We have observed that in some species (e.g., *Hanguana rubinea* and *H. triangulata*, both described below), the position of the stigma on ripe fruit (oblique or central) is influenced by the number of seeds developing in the berry. *Hanguana* berries are trilocular, with a single ovule in each locule, of which one, two or all three can develop. The actual number of seeds which eventually develops presumably depends on pollen availability, but also on species strategy. While the number of seeds which develop per berry is more or less stable in some species (e.g., always single in *H. neglecta*), it can vary in others (e.g., one or two in *H. nitens*, *H. rubinea* and *H. triangulata*; one, two or three in *H. malayana*). While seeds were previously acknowledged as a potential source of characters for *Hanguana* taxonomy, the topic has not been discussed in detail. Descriptions or illustrations of seeds are unfortunately not available for many of the recently described species. Our current study shows that seeds are extremely informative and this topic is, therefore, discussed below. We also highlight the existence of previously overlooked structures occurring in female flowers.

The taxonomic importance of staminodial scales and seeds

Tillich (1996), Tillich & Sill (1999) and Rudall et al. (1999) made major contributions to our understanding of the floral and seed structure of *Hanguana*. This then served as a basis for recent descriptions and was further improved with the recent work of Siti Nurfazilah et al. (2010, 2011) and Mohd Fahmi et al. (2012).

Hanguana flowers are rather uniform across the entire genus and seem to offer few characters helpful in species delimitation. Male flowering material is rarely found in the field (and, therefore, is also scarce in herbaria). The male flowers/inflorescences are short-lived in comparison to female flowers, which progress to fruiting stage (a process lasting several months) while retaining all floral parts practically unchanged or slightly enlarged (e.g., tepals, staminodes, stigma). As fruits offer additional characters, particularly the colour of the ripe fruit and seed morphology, *Hanguana* species are most often described from fruiting material, a trend certain to be continued.

While examining fresh fruiting material of various species from Singapore, the presence of scale-like structures sheathing the base of the three inner staminodes was noticed. None of the previous publications dealing with *Hanguana* mentions their existence (e.g. Airy Shaw, 1980; Tillich, 1996; Bayer et al., 1998; Tillich & Sill, 1999; Siti Nurfazilah et al., 2010, 2011), with the exception of Rudall et al. (1999) who noticed them but misinterpreted them for inner staminodes. Further detailed examinations of fresh as well as herbarium material, however, confirmed that six staminodes are present in each flower (three outer and three inner) and that the three scales are positioned at the base of the three inner staminodes, sheathing them partially of fully. These scales differ in shape and in the presence of a hyaline margin (Fig. 1, 3B, 5B, 7B, 9B, 12B). They preserve well in herbarium specimens and are, therefore, of good taxonomic potential, at least in certain species. While the exact origin and function of these scales is not yet clear and requires further study, it has been suggested (H.-J. Tillich, pers. comm.) that these might be a basal outgrowth of the staminodes, possibly exuding a mucilage or a particular scent to attract a pollinator. We propose here to use the term staminodial scales for these structures. Although staminodial scales have been observed by us in all species we have so far examined from living and herbarium material, it is not yet clear if these are indeed present in all *Hanguana* species.

The seeds of *Hanguana* are unique in the monocots (H.-J. Tillich, pers. comm.). They are more or less bowl-shaped with the hilum positioned at the base of the bowl, the cavity being filled up by a placental tissue. Although the importance of seed size, the varying depth of cavity and the degree of incurving of the rim were briefly mentioned by Siti Nurfazilah et al. (2011), descriptions of seeds were unfortunately not provided by Siti Nurfazilah et al. (2010) for most of the recently described species (*Hanguana exultans, H. pantinensis, H. podzolicola, H. stenopoda*) or the large helophytic species currently interpreted as *Hanguana malayana*.

From our recent work it is obvious that the morphological range of the seed shape, and therefore their taxonomic potential, is considerable. The recently described *Hanguana neglecta* (Niissalo et al., 2014) exhibits seeds which are almost round to

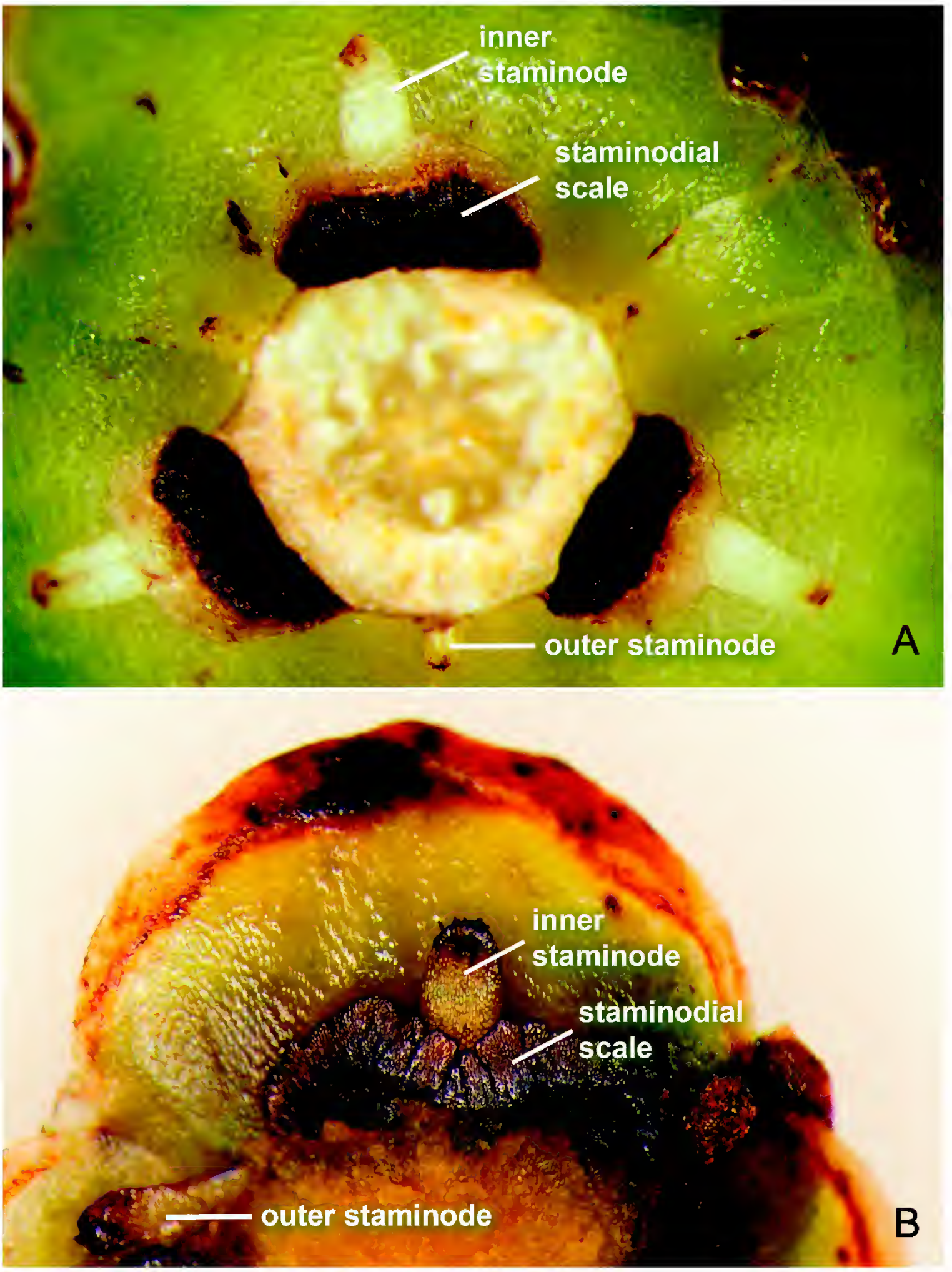

Fig. 1. Detail of staminodial scales at the base of inner staminodes. **A.** *Hanguana triangulata* Škorničk. & P.C.Boyce. Note the presence of a hyaline margin on the staminodial scale. **B.** *Hanguana malayana* (Jack.) Merr. Note the staminodial scale has no hyaline margin and is composed of lobes. (Photos: Jana Leong-Škorničková)

ovoid with a wedge-shaped ostiole. Similar seeds are also observed in *Hanguana corneri* which is described below. The seeds of *Hanguana rubinea* and *H. triangulata*, also described below, although both bowl-shaped, exhibit differently shaped appendages along the proximal part of the rim. As previously mentioned, *Hanguana* species are mostly collected in the fruiting stage, and fruits are often present in ample numbers on the herbarium collections. Seeds, including small structures like appendages, preserve well in dried material, as long as the fruits are collected fully mature or close to maturity. It is possible to study even old material, from which the seeds can be carefully extricated by removing the layer of fruit pulp after the berries are soaked overnight in water at room temperature. In this study, seeds from specimens as old as 1889 collected by H.N. Ridley, were successfully extracted from fruits, providing valuable confirmation of the determinations of *Hanguana triangulata* and *H. neglecta*.

Hanguana in Singapore

The following account presents an identification key and colour plates to all six *Hanguana* species so far known to be present in Singapore, including introduced and cultivated species. Full descriptions are provided for the new taxa, while recently described species are provided with notes to address any additions or deviations from original or recent descriptions, these being clearly referenced. Based on sterile living material we have observed in the field, we suspect the existence of at least one additional species, although field studies are needed to resolve its identity.

The terminology used in the descriptions follows Beentje (2012) and the most recent *Hanguana* works cited above. The type material of the species described from ripe fruiting material also includes spirit material of fruits as well as extracted seeds.

Preliminary IUCN conservation assessments followed Davison et al. (2008) and IUCN guidelines (IUCN, 2012) for local and global assessments respectively. GeoCAT (Bachman et al. 2011) was used to calculate EOO.

The native species are treated first in this account, followed by introduced and cultivated species.

Key to *Hanguana* in Singapore

1a. Large stoloniferous colonial herbs 2
1b. Solitary or clumping herbs lacking stolons 3

2a. Leaves stiffly erect with acute apex; lamina more or less flat or weakly irregularly corrugate, semi-matt green; staminodial scales composed of lobes without hyaline margin; stigma lobes large, flat, connate at base, forming a bluntly triangular to clover-leaf shape, almost obscuring the apex of ovary .... *H. malayana* (sensu Siti Nurfazilah et al. 2010)

2b. Leaves weakly arching, with long-attenuate apex; lamina prominently corrugate, shiny green with visible pattern of lighter and darker green (best observed on young and medium aged leaves); staminodial scales entire with hyaline margin; stigma lobes small, erect, separate, tear-shaped to obovate ..... *H. nitens*

3a. Leaves green on both sides 4
3b. Leaves dark emerald-green above and dark red-purple underneath .... *H. corneri*

4a. Large herbs over 1 m in height; leaves arching; ripe fruits cream-white or ruby-red; seeds bowl-shaped, more or less hemispherical 5
4b. Medium sized herbs not exceeding 0.8 m in height; leaves spreading (not arching); ripe fruits black; seeds ¾ globose to ovoid with wedge-shaped opening ..... *H. neglecta*

5a. Lamina almost flat, abaxially with evenly distributed silky indumentum; ripe fruits ruby-red; stigma lobes connate basally (sometimes imperfectly), with round apices, forming bluntly triangular structure; seed appendage acute ..... *H. rubinea*
5b. Lamina more or less corrugate, abaxially with unevenly distributed flocculose indumentum; ripe fruits cream-white; stigma lobes with sharply acute apices, connate basally (always perfectly), forming sharply triangular structure; seed appendage bluntly bilobed ..... *H. triangulata*

Species native to Singapore

Hanguana neglecta Škorničk. & Niissalo, Phytotaxa 188(1): 15 (2014). – TYPE: Singapore, Bukit Timah Nature Reserve, slopes on lower end of Taban Loop along the stream, 28 May 2014, *Leong-Škorničková, J. & Thame, A. JLS-2793* (holotype SING (including spirit material); isotypes E, KEP, K). (Fig. 2, 3)

Ecology and distribution. In Singapore, *Hanguana neglecta* occurs on slopes in the lowland primary tropical forest of Bukit Timah Nature Reserve, with increased density closer to the stream. More than a century old herbarium records show that this species also occurred in the Nee Soon and MacRitchie areas. Since it was described, we have been able to re-locate a small population in the MacRitchie area (*JLS-3099*, deposited at SING), but there are still no recent sightings of this species from the Nee Soon area. The three currently known records from Peninsular Malaysia are confined to Johor state, and are 56, 107 and 120 years old respectively.

Provisional IUCN conservation assessment. Following the criteria for national and global conservation assessments (Davison et al., 2008; IUCN, 2012), *Hanguana*

Fig. 2. *Hanguana neglecta* Škorničk. & Niissalo. **A.** Habit. **B.** Base of the plant showing semi-ascending leafless stem (inset: detail of fruits, note the stigma composed of three obovate lobes connate at base). **C.** Infructescence with fruits in various stages of ripeness (immature green to glossy black mature fruits). From type *JLS-2793*. (Photos: Jana Leong-Škorničková)

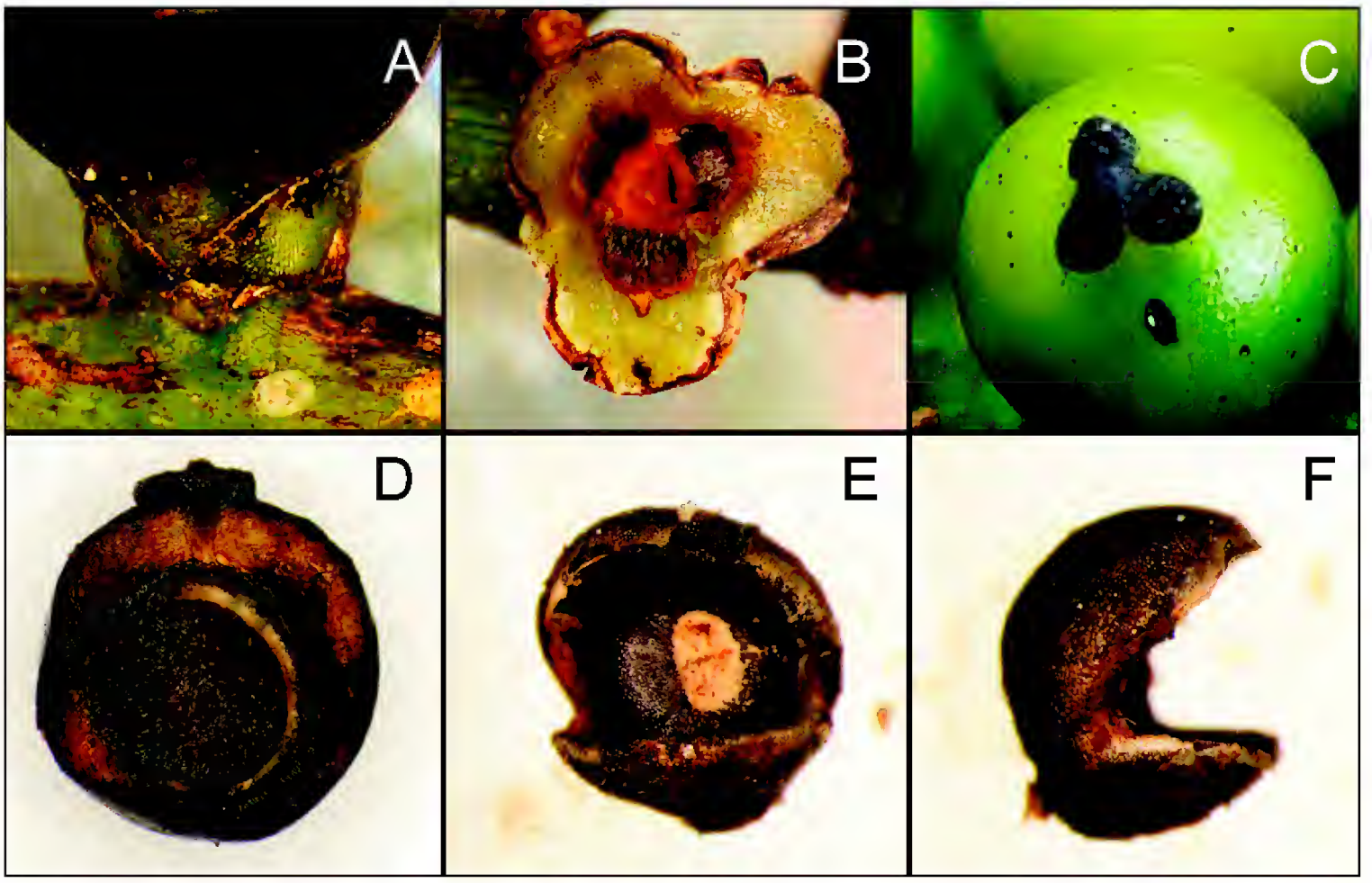

Fig. 3. *Hanguana neglecta* Škorničk. & Niissalo. **A.** Detail of tepals (side view). **B.** Detail of inner tepals, staminodes and staminodial scales. **C.** Detail of stigma on young fruit. **D.** Longitudinal section of fruit, which is always single-seeded. **E.** Seed (top view). **F.** Seed (side view). From type *JLS-2793*. (Photos: Jana Leong-Škorničková)

neglecta should be considered Endangered (EN D) in Singapore and at least Vulnerable (VU B1ab(iii)) globally (for details see Niissalo et al., 2014).

Notes. The first collection of *Hanguana neglecta* on Bukit Timah dates back to 1885 and has been re-collected from the same location several times since. It was Tillich & Sill (1999) who first realised that this species is not *Hanguana malayana*. Without adequate material to hand, they did not pursue a description, but clearly labelled this species as *Hanguana* 'Singapur' in their morphological study. A complete description of *Hanguana neglecta* and a list of specimens examined are provided in Niissalo et al. (2014).

Hanguana nitens Siti Nurfazilah, Mohd Fahmi, Sofiman Othman & P.C.Boyce, Willdenowia 40: 207 (2010). – TYPE: Peninsular Malaysia, Johor Bahru, Mersing, Hutan Simpanan Lenggor, 2°15'72.7"N, 103°43'76.7"E, 55 m, 18 April 2010, *Siti Nurfazilah bt Abdul Rahman, Boyce, P.C. & Ooi Im Hin HA-48* (holotype KEP; not yet deposited as of 5 September 2014). (Fig. 4, 5)

Ecology and distribution. Lowland humid swamp forests, in blackwater mires or slow moving streams. So far known to occur in Peninsular Malaysia and Singapore.

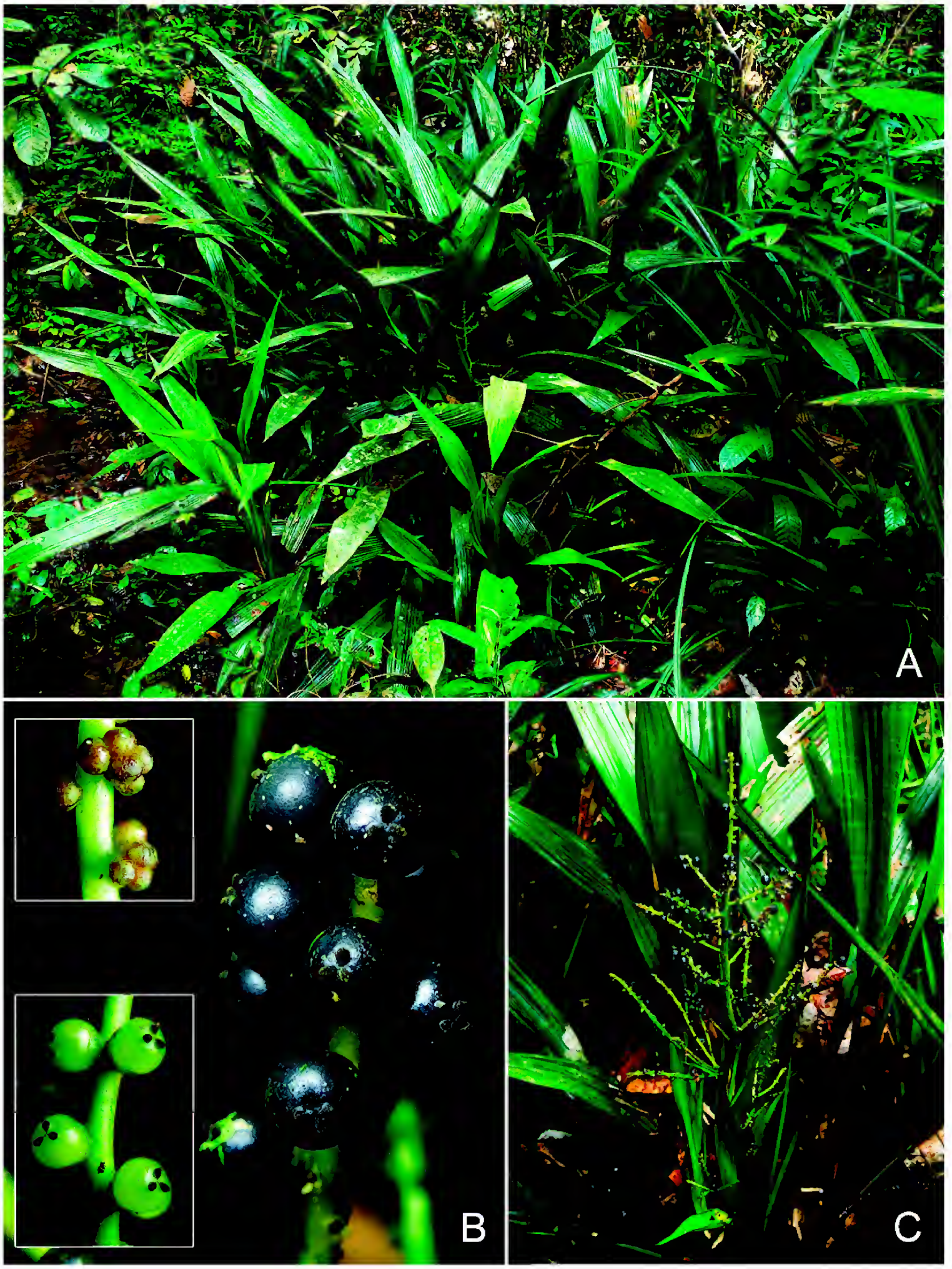

Fig. 4. *Hanguana nitens* Siti Nurfazilah, Mohd Fahmi, Sofiman Othman & P.C.Boyce. **A.** Habit. **B.** Detail of ripe fruits (inset upper left: male flower buds; inset lower left: young unripe fruits); note the separate, erect, pointed stigma lobes. **C.** Infructescence. From native population at MacRitchie sector, Central Catchment Nature Reserve, *JLS-3029*. (Photos: Jana Leong-Škorničková)

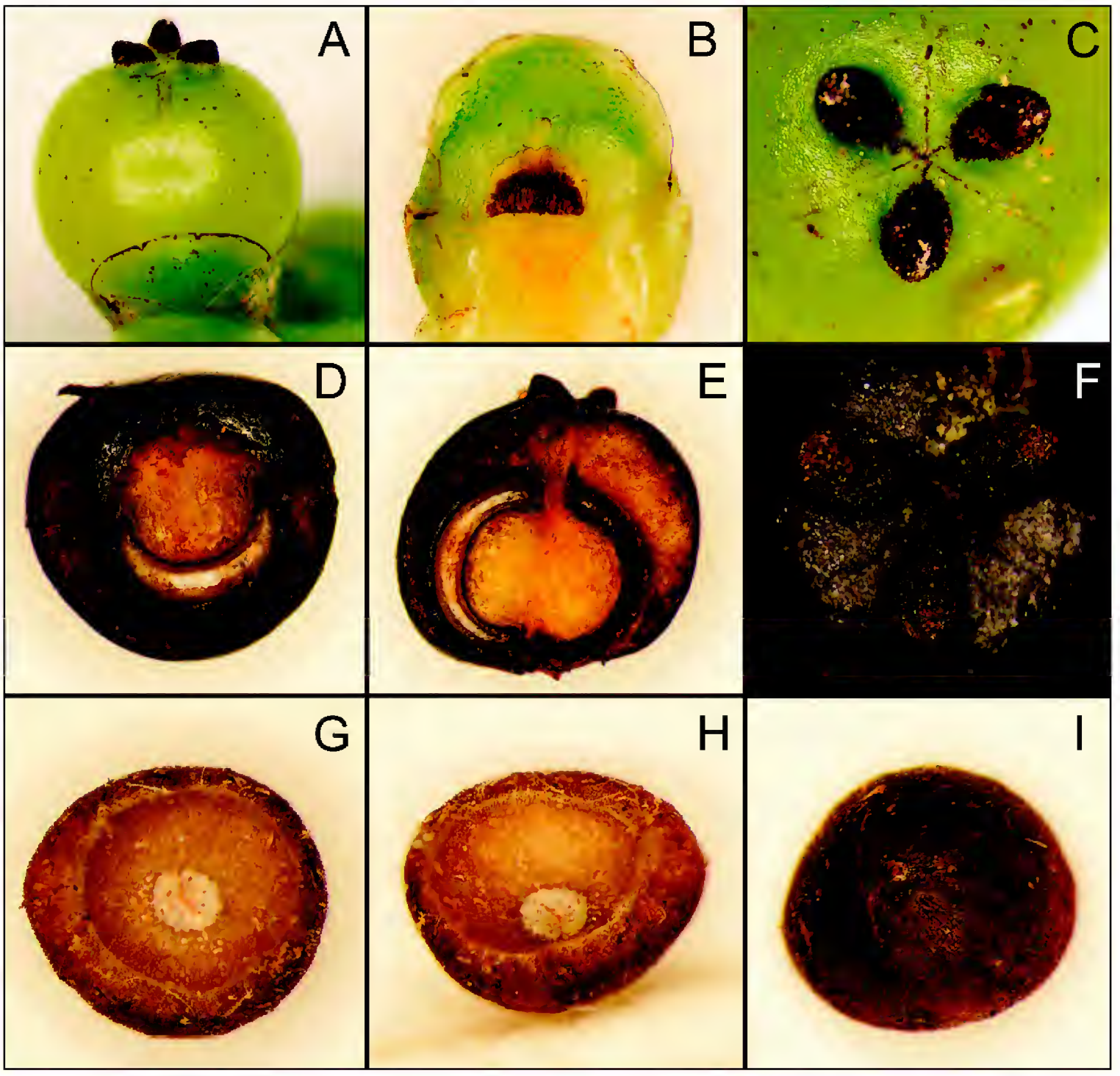

Fig. 5. *Hanguana nitens* Siti Nurfazilah, Mohd Fahmi, Sofiman Othman & P.C.Boyce. **A.** Detail of tepals (side view). **B.** Detail of inner tepal, staminode and staminodial scale. **C.** Detail of stigma on young fruit. **D.** Cross section of fruit showing single seed and two empty locules. **E.** Longitudinal section of two-seeded fruit. **F.** Detail of stigma on fully ripe fruit. **G.** Seed (top view). **H.** Seed (side lateral view); note there are no appendages along the incurved rim. **I.** Seed viewed from bottom. From native population at MacRitchie sector, Central Catchment Nature Reserve, *JLS-3029.* (Photos: Jana Leong-Škorničková)

Provisional IUCN conservation assessment. Although when first described *Hanguana nitens* was known to occur in three locations in Johor, a revision of herbarium material at SING and KEP suggests that this species is more widespread, with specimen records from Pahang, Selangor and Perak. Based on an EOO, which is larger than 20,000 $km^{2,}$ this species can be provisionally placed into category of Least Concern (LC) following the IUCN criteria (IUCN, 2012). Future explorations should, however, focus on an assessment of population sizes and potential decline in extent and/or quality of habitat

and adjust accordingly with more accurate data. In Singapore, *Hanguana nitens* is so far known from a single locality in the Central Catchment Nature Reserve with an area of occupancy (AOO) of c. 200 m^2 and a predicted continuing decline in quality of habitat. The colony of about 150 full-sized shoots consists of both male and female plants, although considering the stoloniferous colonial nature of *Hanguana nitens*, it almost certainly represents only a few individuals (genotypes), and as such the species should be considered Critically Endangered (CR D) at the national level (Davison et al., 2008). Conservation should focus on regular harvesting of ripe fruits, re-introduction into suitable habitats, and establishment and propagation of material to saturate potential horticultural interest.

Additional specimens examined. SINGAPORE: **Bukit Panjang:** 1901, *Ridley, H.N.1397* (SING); ibidem, 1906, *Ridley, H.N. s.n.* (SING); **Bukit Timah Road:** 19 Dec 1900, *Ridley, H.N. s.n.* (SING); **Central Catchment Nature Reserve:** MacRitchie sector, 21 May 2014, *Leong-Škorničková, J. & Thame, A. JLS-3028* (SING); ibidem, 1 Jul 2014, *Leong-Škorničková, J. & Thame, J. JLS-3029* (SING); **Changi:** 4 Oct 1890, *Ridley, H.N. s.n.* (SING); **Chua Chu Kang** [Choa Chu Kang]**:** 1905, *Ridley, H.N. s.n.* (SING); **With no precise locality:** Feb 1837, *Gaudichaud, M. 112* (P, 3x).
PENINSULAR MALAYSIA: **Johor:** sine dat., *Best 8290* (SING); Batu Pahat, Ayer Hitam F. R., 21 Nov 1965, *Ng KEP 100008* (KEP); Ponitan, Pengkalan Raja, sine dat., *Alvins 72* (SING); ibidem, 28 Jun 1939, *Ngadiman 36651* (SING); Kota Tinggi, Nam Heng estate, 20 Mar 1926, *Teruya 640* (SING). **Pahang:** Kuantan, Sg. Baging F. R., 6 Oct 1989, *Khairuddin FRI 35418* (KEP, 2 sheets). **Selangor:** Petaling, Batu Tiga, Feb 1904, *Ridley, H.N. s.n.* (SING, 2 sheets). Kuala Lumpor, 1890, *[?Ridley] s.n.* (SING); Klang, Changgang, 3 Oct 1937, *Mohd Nur s.n.* (SING). **Perak:** Hilir Perak, Hutan Melintang F.R., 13 Sep 1967, *Ng FRI 5698* (KEP); Taiping, Batu Togoh, Jun 1888, *Wray 2128* (SING).
Note: Specimens of *Hanguana nitens* from Johor cited by Siti Nurfazilah et al. (2010) have not yet been deposited at KEP as of 5 September 2014.

Notes. The original description of *Hanguana nitens* as given by Siti Nurfazilah et al. (2010) largely agrees with our observation of the Singapore population, although the plants in Singapore are overall more robust, reaching 2 m in height. The largest leaves reach up to 2.2 m in length with leaf blades to 115 × 13.5 cm. Female inflorescences/ infructescences are also more robust with the peduncle and rachis reaching 1.1 m and the median branches on the lowermost levels reaching up to 27 cm in length. Male inflorescences were not included in the original description of the species (Siti Nurfazilah et al., 2010). We observed young male inflorescences in May, but with as yet unopened buds. The structure of the inflorescences is similar to the female plants, but generally much more slender. Flower buds appear in dense clusters of four to seven. The tepals are bright green with a bronze tinge externally (Fig. 4B - inset upper left).

Hanguana nitens certainly has ornamental potential with its beautiful glossy corrugate leaves which, especially in young leaves, exhibit a pattern of mid-green and dark green (Fig. 4). Its landscape usage may be similar to *Hanguana malayana* (as currently applied) but, as observed in the field, *H. nitens* is better suited to partially shaded areas where the largest individuals occur, compared to *H. malayana*, which thrives best in full sun.

Hanguana rubinea Škorničk. & P.C.Boyce, **sp. nov.**
Close to *Hanguana pantinensis* in fruits ripening to ruby-red, but differing by a more compact infructescence composed of shorter, stiffer partial inflorescences attached almost perpendicularly to rachis, median branches to 11 cm with lateral branches progressively shorter, and basally connate stigma lobes (compared to partial infructescences composed of slender markedly erect branches to 14 cm long, median and lateral branches of almost same length, and free stigma lobes). *Hanguana rubinea* is also similar to *H. triangulata* (described below), but differs by fruits ripening to ruby-red and stigma lobes connate basally (sometimes imperfectly) with free round apices forming bluntly triangular structure (vs ripe fruits cream-white and stigma lobes with sharply acute apices, connate at base, forming a sharply equilaterally triangular structure in *H. triangulata*). – TYPE: Singapore, Central Catchment Nature Reserve, forest around Upper Seletar Reservoir, 19 August 2014, *Leong-Škorničková, J. & Thame, A. JLS-3037* (holotype SING; isotypes E, KEP). (Fig. 6, 7)

Herbaceous, dioecious mesophyte to 1.5 m tall; *stem* terete, to 2.5 cm in diam., basally semi-ascending, with age becoming leafless at base, terminally ascending with crown of up to 25 leaves; *stolons* absent. ***Leaves*** to 165 cm long, spreading then arching, bases imbricate with hyaline margins (young leaves), turning erose-marcescent with age; *pseudopetiole* 50–85 cm long, c. 13 mm wide, accounting for 1/3–1/2 of entire leaf length, roundly channelled with sharp margins; *leaf blade* 65–95 × 12–16 cm, narrowly elliptic, base attenuate, tip long and narrowly attenuate with apicule 15–20 mm, leathery, adaxially mid to dark green, sparsely hairy (silky appressed hairs evenly distributed; less visible in older leaves), abaxially lighter green when fresh, sparsely with silky appresed hairs evenly distributed (denser than on upper surface); *midrib* weakly impressed, of the same colour as the rest of the lamina adaxially, round-raised, mid green, almost glabrous and shiny abaxially. ***Male inflorescences*** not observed, ***female inflorescences*** erect at anthesis, of same structure and dimensions as infructescence. ***Infructescence*** erect, comprising up to 8 partial, whorled, alternate-secund, thyrsoid infructescences plus a terminal spike; *partial infructescences* spreading almost perpendicularly to rachis; *peduncle and rachis* together up to 50 cm tall, dark purple-brown when fresh, conspicuously pale brown-grey flocculose, visible portion of peduncle up to 20 cm long; one sterile bract per peduncle, foliaceous, persistent, narrowly ovate with a basal claw, 88 (incl. 8 cm long claw) × 14.5–11.5 cm; *bract subtending partial infructescences* similar to sterile bracts, the bract supporting most basal partial infructescence c. 38 × 9 cm, diminishing in size distally along the infructescence and fully reduced in uppermost partial infructescences; *partial infructescences* each comprising up to 11 branches at basal levels (occasionally two branches connate at base), fewer towards the apex of the inflorescence, branches arising simultaneously from the axil of the subtending bract, lateral branches progressively shorter in length (outermost lateral branches c. ¾ of the median branch), median branches at basal levels usually further branched 7–11 cm long, 3–4 mm in diam. ***Female flowers*** scattered, always solitary, sessile, all with an associated minute bract and bracteole; *perianth* composed of 6 tepals in two

Fig. 6. *Hanguana rubinea* Škorničk. & P.C.Boyce. **A.** Habit. **B.** Detail of rachis with prominent dense flocculose indumentum, which is easily rubbed off (inset: detail of fruits and stigma). **C.** Infructescence. From type *JLS-3037*. (Photos: Jana Leong-Škorničková)

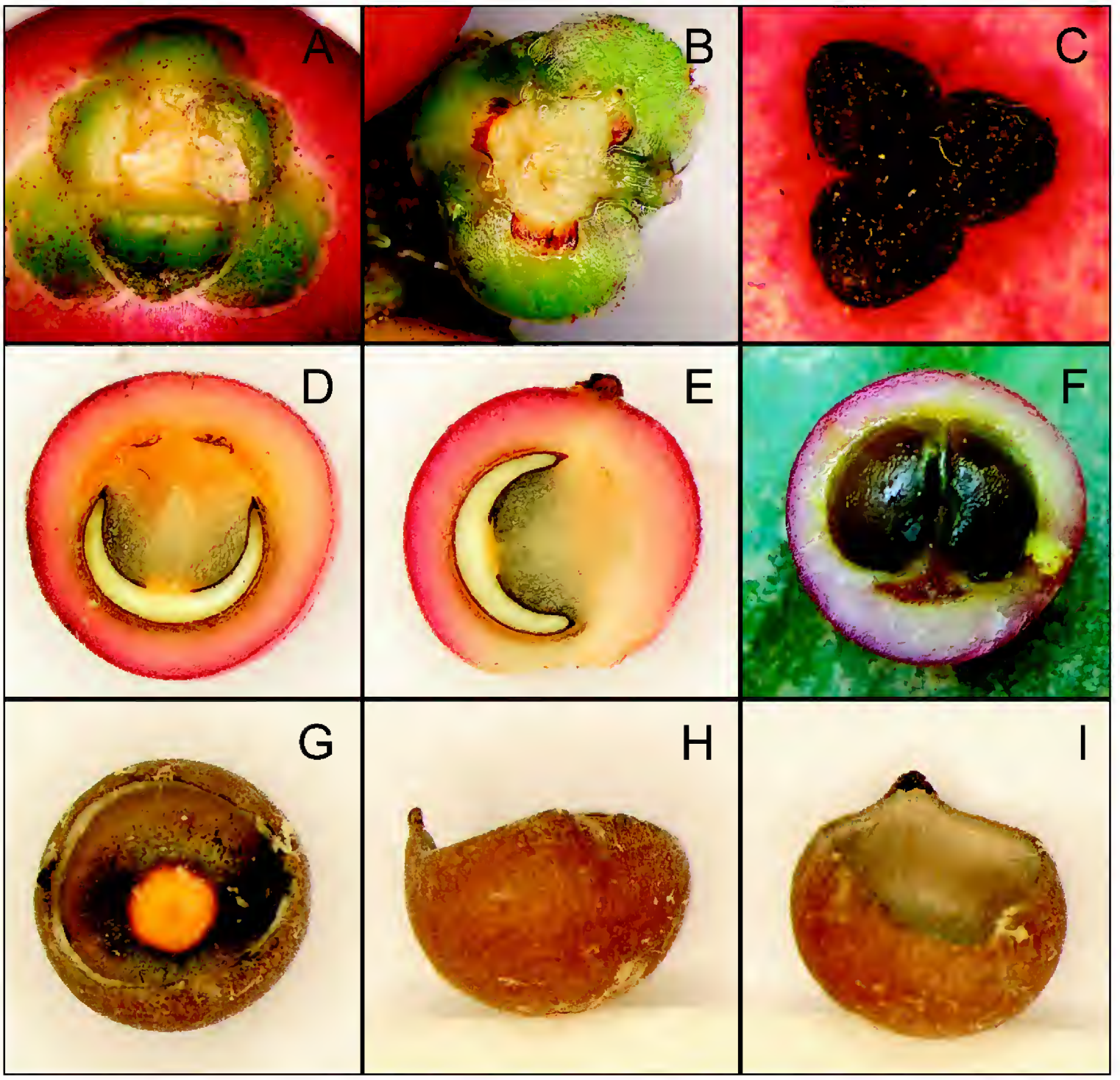

Fig. 7. *Hanguana rubinea* Škorničk. & P.C.Boyce. **A.** Detail of tepals tightly clasping the base of the fruit. **B.** Detail of inner tepals, staminodes and staminodial scales. **C.** Detail of stigma. **D.** Cross section of fruit showing single seed and two empty locules. **E.** Longitudinal section of fruit. **F.** Fruit in top view, after removal of apical half of the pulp, showing two seeds and one empty locule; note the acute appendage at the top of the seed. **G.** Seed (top view). **H.** Seed (side lateral view). **I.** Seed in semi-lateral view showing an acute appendage. From type *JLS-3037*. (Photos: Jana Leong-Škorničková)

whorls tightly clasping ovary/fruit in fresh material, all tepals with prominent bulbous thickening at base (more prominent in outer whorl), light green with more or less dense minute red-brown speckles, margin c. 0.2 mm wide, hyaline translucent white; *outer tepals* semi-circular, 1.5–2.5 mm long, c. 2.5 mm broad, connate at base, sparsely arachnoid; *inner tepals* almost semi-circular, 3–3.5 mm long, 4–4.5 mm broad at base, free to base, almost glabrous (occasionally sparsely arachnoid); *staminodes* 6, in two whorls, pale green to cream white, triangular, *outer staminodes*, 0.5 mm long, 0.5 mm

broad at base, inner staminodes longer, c. 1 mm long, 0.5 mm at base, each basally sheathed with a broad narrow scale (often shallowly bilobed), c. 0.5 mm long, and c. 2 mm broad, brown with translucent margin; *ovary* green, ovoid, glossy green; *stigma* 3-lobed, each lobe 1.2–1.4 mm long (fruiting material), broadly ovate (-to bluntly trullate) with round apex, lobes connate basally (sometimes imperfectly) with free apices forming bluntly triangular structure (c. 2.5 mm in diam. in fruiting material) with points of connation seen as grooves, green (flowering stage), matte dark brown (fruiting stage). ***Ripe fruit*** globose, 9–10 mm diam., dark pink-red externally, pulp 1–2 mm thick, cream-white, fairly hard, exuding yellow juice when disturbed, ripening from bright green through cream-white to dark pink-red; *seeds* 1–2 per fruit, c. 5 × 4 mm, brown, bowl-shaped with slightly incurved margins, with a triangular appendage positioned on the distal part of the rim, c. 5 × 4 mm, deeply excavated, cavity filled with placental tissue.

Etymology. The specific epithet is derived from the ruby-red colour of the ripe fruits.

Ecology and distribution. Growing on the slopes of, or in the proximity of, small/ seasonal streams in primary or partially disturbed primary lowland forest. So far endemic to Singapore.

Provisional IUCN conservation assessment. Based on our recent collections and on reliably identified fertile herbarium records from the past 30 years, *Hanguana rubinea* occurs in four locations in Singapore (Bukit Timah, Mandai, MacRitchie and Seletar). The extent of occurrence (EOO) is c. 12 km^2, the habitat is fragmented and, based on our observations, the number of adult individuals is fewer than 250, with fewer than 50 individuals in each sub-population. With impending and proposed developments in some of the existing locations, and serious damage caused by wild boars observed in two locations, further decline of the populations and further fragmentation of the habitat is foreseen. *Hanguana rubinea* should be therefore considered as Critically Endangered (CR C.2) locally (Davison et al., 2008), and because it is so far endemic to Singapore, also globally CR B1ab(iii,v); C2a(i)) (IUCN, 2012).

Additional specimens examined. SINGAPORE: **Bukit Timah Nature Reserve:** upper end of Taban Loop, 28 May 2014, *Leong-Škorničková, J. & Thame, A. JLS-2791* (SING); **Central Catchment Nature Reserve:** sector 53 [MacRitchie] 29 Apr 1992, *Yong et al. NSR 598* (SING); MacRitchie, off Shinto Trail, 1 Jul 2014, *Leong-Škorničková, J. & Thame, A. JLS-3027* (SING); MacRitchie, off Lornie Trail, 14 Aug 2014, *Leong-Škorničková, J. & Thame, A. JLS-3030* (SING); **Chan Chu Kang:** 14 Apr 1890, *Goodenough, J.S. s.n.* (SING); **Mandai:** Mandai Forest, 6 Jan 2009, *Gwee, A.T. SING 2009-09* (SING); Mandai forest, 19 Aug 2014, *Leong-Škorničková, J. & Thame, A. JLS-3034* (SING; sterile); **Ponggol:** 1905, *Ridley, H.N. s.n.* (SING).
Note: The following two specimens might also represent *Hanguana rubinea*, but the specimens deviate slightly from typical *H. rubinea* and are cited here with caution: Mandai Road, 28 Jul 1929, *Corner, E.J.H s.n.* (SING); Seletar, 29 Mar 1889, *Ridley, H.N. 170* (SING).

Notes. In late fruiting stage, *Hanguana rubinea* is easy to recognise by its pretty ruby-red fruits. In early fruiting stages, when the ovaries are still creamy white, it can potentially be mistaken for *Hanguana triangulata* with which it shares a similar infructescence structure with partial infructescence branches attached almost perpendicularly to the rachis. However, the shape of the stigma is unmistakeable in the latter species as the three stigmatic lobes with acutely sharp apices form an equilateral triangle (compare Fig. 7C and 9C). Further differences are in the leaves and the seeds. The leaf blades of *Hanguana rubinea* are almost flat, or only weakly corrugate, with an evenly distributed abaxial silky indumentum, compared to *H. triangulata* which has corrugated leaves and the indumentum is more visible and flocculose. While the seeds of both species are bowl-shaped, *Hanguana rubinea* has an acute appendage along the rim (Fig. 7G–I) compared to a blunt appendage composed of two sub-lobes in *H. triangulata* (Fig. 9G–I).

Hanguana triangulata Škorničk. & P.C.Boyce, **sp. nov.**
Similar to *Hanguana exultans* by fruits ripening cream-white to pale yellow, but differing by a more compact infructescence composed of shorter, stiffer partial inflorescences attached almost perpendicularly to rachis and stigma lobes with sharply acute apices, connate at base, forming an equilateral triangular structure (vs partial infructescence somewhat erect, attached at c. 45° to rhachis and stigma composed of three free lobes). – TYPE: Singapore, Bukit Timah Nature Reserve, slopes around Taban Loop, 28 May 2014, *Leong-Škorničková, J. & Thame, A. JLS-2789* (holotype SING). (Fig. 8, 9)

Herbaceous, dioecious mesophyte to c. 1.6 m tall; *stem* terete, to 2.5 cm in diam., basally semi-ascending, with age becoming leafless, terminally ascending with crown of up 20 leaves; *stolons* absent. ***Leaves*** to 150 cm long, spreading then arching; bases imbricate, margins hyaline (young leaves), turning erose-marcescent with age; *pseudopetiole* 40–50 cm long, c. 12 mm wide, accounting for c. 1/3 of entire leaf length, roundly channelled with sharp margins, sparsely softly flocculose; *leaf blade* 90–106 × 12–13 cm, narrowly elliptic, base attenuate, tip long and narrowly attenuate with apicule to 5 mm, leathery, adaxially dark green, sparsely hairy (silky appressed hairs evenly distributed; less or not visible in older leaves), abaxially mid-green, somewhat shiny, covered with silky flocculose hairs (unevenly distributed, much denser than on upper surface); *midrib* weakly impressed, almost of the same colour as the rest of the lamina, sparsely flocculose (especially towards the base) adaxially, round-raised, mid green, sparsely flocculose and shiny abaxially. ***Female*** and ***male inflorescences*** not observed, although, based on observations of infructescence architecture, almost certainly erect at anthesis. ***Infructescence*** erect, comprising up to 6 partial, whorled, alternate-secund, thyrsoid infructescences plus a terminal spike; *partial infructescences* spreading almost perpendicularly to rachis; *peduncle and rachis* together up to 70 cm tall, green when fresh, conspicuously pale brown-grey flocculose, visible portion of peduncle up to 40 cm long; sterile bracts two per peduncle, foliaceous, narrowly ovate with a

Fig. 8. *Hanguana triangulata* Škorničk. & P.C.Boyce. **A.** Habit. **B.** Detail of fruits and the typical sharply triangulate stigma. **C.** Inflorescence. From type *JLS-2789*. (Photos: Jana Leong-Škorničková)

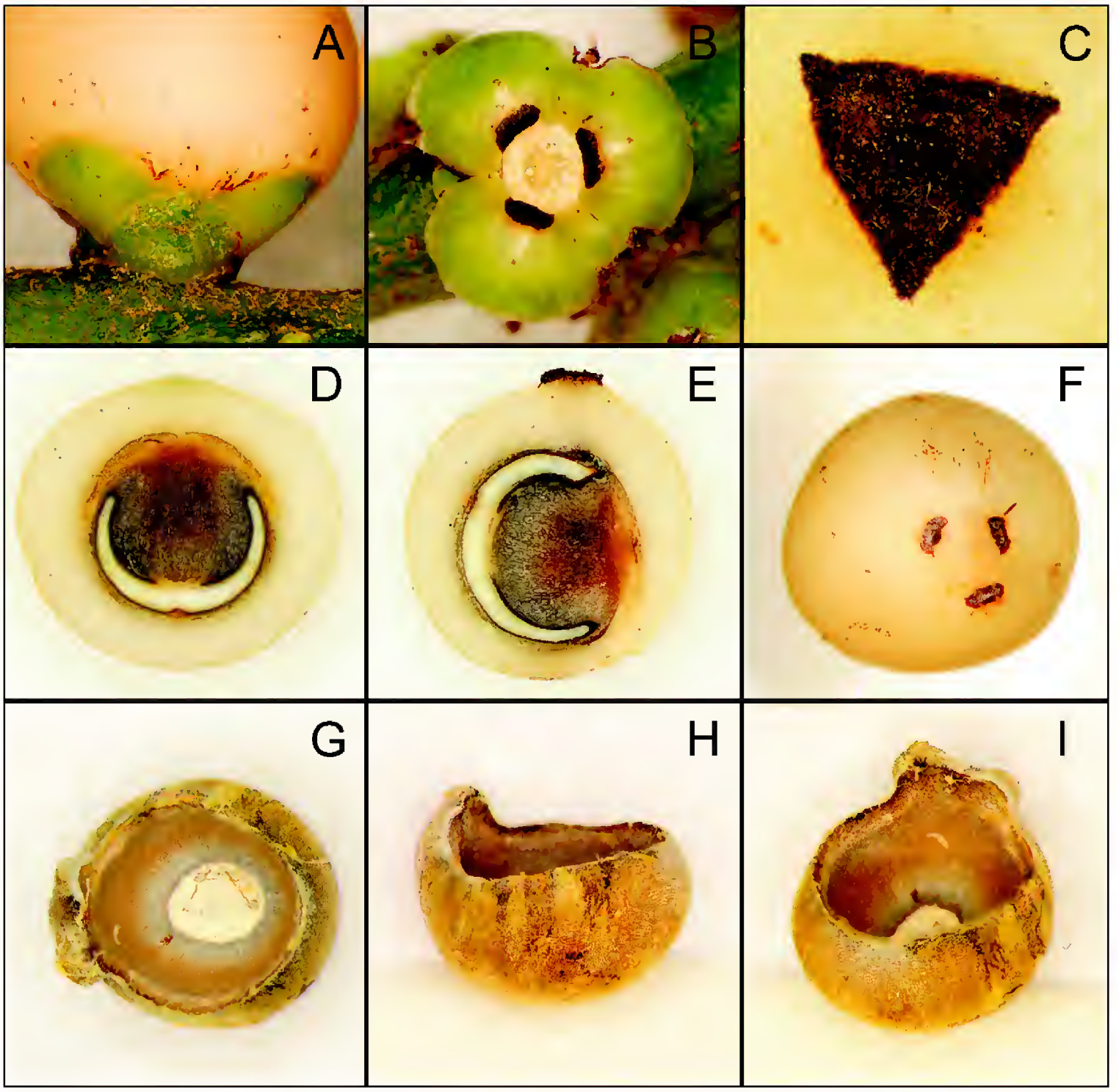

Fig. 9. *Hanguana triangulata* Škorničk. & P.C.Boyce. **A.** Detail of tepals (side view). **B.** detail of inner tepals, staminodes and staminodial scales. **C.** Detail of stigma. **D.** Cross section of fruit showing single seed and two empty locules. **E.** Longitudinal section of fruit. **F.** Fruit in basal view, after removal of tepals, showing three staminodial scales still attached. **G.** Seed (top view). **H.** Seed (side lateral view). **I.** Seed (semi-lateral view showing a blunt appendage composed of two sub-lobes. From type *JLS-2789*. (Photos: Jana Leong-Škorničková)

basal claw, persistent, 36–71 × 6.5–11.5 cm; *bract subtending partial infructescences* similar to sterile bracts, the bract supporting most basal partial infructescence 20 × 3 cm, diminishing in size distally along the infructescence and fully reduced in uppermost partial infructescences; *partial infructescences* each comprising up to 10 branches at basal levels (fewer towards the apex of the inflorescence), branches arising simultaneously from the axil of the subtending bract, lateral branches progressively shorter in length (outermost lateral branches 2/3–1/2 of the median branch), median branch 6–8 cm long, c. 3 mm in diam. ***Female flowers*** scattered, always solitary,

sessile, all with an associated minute bracteole; *perianth* composed of 6 tepals in two whorls tightly clasping ovary/fruit in fresh material, outer 3 tepals broadly triangular with round apex, all tepals with prominent bulbous thickening at base (more prominent in outer whorl), light green, margin c. 0.2 mm wide, hyaline translucent white; *outer tepals* semi-circular, c. 2 mm long, c. 2.8 mm broad, connate at base, sparsely arachnoid; *inner tepals* almost semi-circular, c. 3 mm long, c. 4 mm broad, free to base, almost glabrous (occasionally sparsely arachnoid); *staminodes* 6, in two whorls, cream-white, triangular to narrowly triangular, *outer staminodes* minute, c. 0.3 mm long, 0.2 mm broad at base, *inner staminodes* larger, c. 1 mm long, 0.3 mm at base, each basally sheathed with semi-circular staminodial scale, c. 0.8 mm long, and c. 1.3 mm broad, brown with irregular (usually bilobed) translucent margin; *stigma* 3-lobed, lobes connate basally, each lobe c. 1.5 mm long (fruiting material), trullate with sharply acute apex, lobes perfectly connate basally forming equilateral triangle (c. 2.5 mm in diam. in fruiting material), raised, matte dark brown in late fruiting stage. ***Ripe fruit*** cream externally, pulp c. 2 mm thick, hard, cream-white, exuding yellow juice when disturbed, globose, 9–10 mm diam., ripening from bright green to cream-white; *seeds* usually two per fruit, c. 5–6 × 4.5–5 mm, brown, broadly boat-shaped to bowl-shaped, deeply excavated, with a blunt appendage composed of two sub-lobes positioned on the distal part of the rim, cavity filled with placental tissue.

Etymology. The specific epithet refers to the sharply triangular shape of the stigma, a character which is conspicuous even in herbarium material.

Ecology and distribution. Hanguana triangulata is an undergrowth species growing in the proximity of streams in lowland evergreen forest. So far endemic to Singapore.

Provisional IUCN conservation assessment. Only two locations in Singapore with fewer than 20 individuals in all (AOO 0.5 km2) were observed during recent fieldwork. There are signs of severe damage caused by wild boars in some adult individuals, thereby warranting a status of Critically Endangered (CR D) at the national and, given its endemic status, also global levels (Davison et al., 2008; IUCN, 2012). Immediate conservation efforts to ensure the survival of this species have focused on the harvesting of ripe fruits, optimising the protocol for ex situ cultivation and multiplication, and re-introductions to suitable habitats.

Additional specimens examined. SINGAPORE: **Bukit Timah:** 1898, *Ridley, H.N. 9531* (SING); Bukit Timah Nature Reserve, slopes around Taban Loop, 12 Aug 2014, *Leong-Škorničková, J. & Thame, A. JLS-2792* (SING); ibidem, slopes around Tiup Tiup path, 14 Sep 2014 , *Leong-Škorničková, J. JLS-3046* (SING); **Central Catchment Nature Reserve:** forests around Upper Seletar Reservoir, 19 Aug 2014, *Leong-Škorničková, J. & Thame, A. JLS-3036* (SING, sterile); **Kranji:** 5 Aug 1889, *Goodenough, J.S. s.n.* (SING); **Pulau Ubin:** Aug 1898, *Ridley, H.N. s.n.* (SING).

Notes. Hanguana triangulata is currently known to occur only in the Bukit Timah Nature Reserve (confirmed from fruiting material) and in the Central Catchment

Nature Reserve in forests around Upper Seletar Reservoir (identification based on sterile material only). Historical herbarium records suggesting its past presence in Kranji and Pulau Ubin are both over a century old. The sharply triangular stigma is easily observable in dried material, although the sharp tips may curve somewhat downwards. Seeds extracted from material as old as 1889 match well to seeds extracted from recently collected material in Bukit Timah Nature Reserve (both exhibiting the blunt weakly bilobed appendage, see Fig. 9G–I).

Introduced and naturalised species

Hanguana corneri Škorničk. & P.C.Boyce, **sp. nov.**
Unique amongst currently known *Hanguana* species by its leaves which are shiny emerald-green above and deep purple and silvery flocculose beneath. – TYPE: Peninsular Malaysia, Johor, Sungai Berassau, Mawai-Jemulang Road, 7 February 1935, *Corner, E.J.H.s.n.* (holotype SING!). (Fig. 10)

Herbaceous, dioecious mesophyte to c. 0.8 m tall; *stem* terete, to 2 cm in diam., basally semi-ascending, with age becoming leafless at base, terminally with crown of 15–20 leaves; *stolons* absent. ***Leaves*** to 85 cm long, spreading then arching, bases imbricate with hyaline margins (young leaves), turning erose-marcescent with age; *pseudopetiole* 10–20 cm long, accounting for ¼–⅓ of entire leaf length, roundly channelled with sharp margins; *leaf blade* 54–66 × 10–14.5 cm, narrowly elliptic with undulate margins, base attenuate, tip narrowly acute with apicule 2–3 mm, softly leathery, adaxially dark green, with glossy lustre, abaxially purple red, with dense soft appressed flocculose indumentum; *midrib* weakly impressed, mid-green (much lighter than the rest of the lamina) adaxially, round-raised, light pink-brown, flocculose abaxially. ***Female inflorescence*** not observed, although, based on observations of infructescence architecture, almost certainly erect at anthesis. ***Male inflorescence*** erect at anthesis, comprising 6 partial inflorescences and a terminal spike; *peduncle* and *rachis* c. 30 cm long; *peduncle* c. 6 cm long, no sterile foliaceous bract observed; *bract subtending lowest partial inflorescence* foliar, narrowly ovate, c. 19 cm long (width obscured in type specimen), with basal claw c. 2 cm, distally diminishing in size to narrowly triangular bracts, fully reduced at uppermost partial inflorescences. ***Male flowers*** scattered, in groups of (2–)3–5; *perianth* composed of 6 tepals in two whorls, all tepals ovate, greenish (according to a note on type specimen), *outer tepals* c. 1 mm long, *inner tepals* c. 1.5 mm long (measured from dried flower buds). ***Female flowers*** scattered, in pairs or solitary, sessile, all with an associated minute bract and bracteole; *perianth* composed of 6 tepals in two whorls tightly clasping fruit (in dry material), all tepals with prominent bulbous thickening at base (more prominent in outer whorl); *outer tepals* semi-circular, c. 1 mm long, c. 1.5 mm broad, connate at base; inner tepals almost semi-circular, c. 2 mm long, 2–2.5 mm broad, free to base; *staminodes* and staminodial scales not observed; *stigma* 3-lobed, each lobe c. 7 mm long (dried fruiting material), ovate with blunt apex, lobes perfectly connate basally with free

Fig. 10. *Hanguana corneri* Škorničk. & P.C.Boyce. **A.** Habit. **B.** Base of the plant showing semi-ascending leafless stem. **C.** Detail of lamina abaxially, showing the unique dark purple-red coloration and dense cover of silvery flocculose hair. From plant growing at Bukit Timah Nature Reserve, *JLS-2790*. (Photos: Jana Leong-Škorničková)

apices forming bluntly triangular structure with raised centre (c. 1.1 mm in diam., in dried fruiting material), matte dark brown in late fruiting stage. ***Infructescence*** erect, comprising up to 5 partial alternate-secund, thyrsoid infructescences plus a terminal spike; *partial infructescences* semi-erect, at an angle c. 40°–50° to rachis; *peduncle* and *rachis* together up to 45 cm tall; *peduncle* up to 10 cm long, one sterile bract per peduncle, foliaceous, persistent, narrowly ovate with basal claw, c. 35 (incl. 5 cm claw) × c. 6 cm; *bract subtending partial infructescences* similar to sterile bract, distally diminishing in size to narrowly triangular bracts, fully reduced in uppermost partial inflorescences; *partial infructescences* each comprising up to 5 branches at basal levels, fewer towards the apex of the inflorescence, branches arising simultaneously from the axil of the subtending bract, lateral branches progressively shorter in length (outermost lateral branches c. ¾ of the median branch), both median and lateral branches usually further branched, median branch to 10 cm long, c. 2.5 mm in diam. ***Fruit*** (described from old dried fruit) globose, c. 4 mm in diam.; seeds brown, c. 3–3.5 mm in diam., ¾ globose to ellipsoid, ostiole wedge-shaped accounting for c. ¼ of the seeds, deeply excavated, cavity filled with placental tissue.

Etymology. We name this species for E.J.H. Corner (1906–1996), a botanist and mycologist who first collected this beautiful species. He was a giant among tropical Asian botanists and, in particular, for 'Malayan' botany.

Ecology and distribution. Native to Peninsular Malaysia (Johor) and introduced to Singapore. According to the notes on Corner's specimen, this species occurs in swampy forests with flowering occurring in February. Populations of what is almost certainly the same species, although not occurring in swampy areas, are known from SW Sarawak (Boyce, pers. obs.), notably in the Penrissen Range, where plants occur intermixed with another two as-yet undescribed *Hanguana* species a few metres from a precipitous escarpment marking the border with Kalimantan Barat.

Provisional IUCN conservation assessment: Owing to a lack of data on the distribution and population sizes of this species in Peninsular Malaysia, and the uncertainty as to whether this species also extends to Borneo, we propose that this species be treated as Data Deficient (DD).

Additional specimens examined. SINGAPORE: **Bukit Timah Nature Reserve:** slopes around Taban Loop, 28 May 2014, *Leong-Škorničková, J. & Thame, A. JLS-2790* (SING).

Notes. A single plant of this conspicuous species has been discovered in the Taban Loop area of Bukit Timah Nature Reserve (BTNR). A revision of material from Peninsular Malaysia at SING revealed the existence of a male flowering specimen of this species, collected by E.J.H. Corner in 1935 from Sungai Berassau (Peninsular Malaysia, Johor). Although it is almost certain that living plants of this species were brought to Singapore from a field trip conducted by Corner, who at that time worked in Singapore Botanic Gardens (1929–1945), it is not clear how they ended up on Bukit

Timah. The first author has observed, as part of earlier work on native Zingiberales, that several *Scaphochlamys* species, all of them certainly not native to Singapore, also occurred around the same area. Some of these *Scaphochlamys* species were described as new to science by R.E. Holttum from herbarium material collected by Corner. Holttum (1950) explicitly stated that he based his descriptions solely on the herbarium material and that he had never seen these species alive, making any connection of Holttum to the Bukit Timah plantings unlikely. According to John Dransfield and Ruth Kiew, who both pursued their PhD studies under Corner's supervision and knew him well, it is also highly unlikely that it was Corner himself who planted these on Bukit Timah (J. Dransfield, R. Kiew, pers. comm.). While there are no official records, we tend to agree with a suggestion by Dransfield, that living plant material was most likely brought back to Singapore Botanic Gardens by Corner's field assistants Kiah and Md. Nur. When and by whom the material was planted on Bukit Timah, however, remains unclear.

Several plants of *Hanguana corneri* are cultivated in the living collections at the Forest Research Institute, Malaysia. These collections, unfortunately, lack exact provenance record, although they are also likely to be from Johor (Saw Leng Guan, pers. comm.).

The above description is based on currently available material consisting of sterile living plants in the Bukit Timah Nature Reserve, a male dried specimen (the type), and old infructescences observed in the living collections of the Forest Research Institute, Malaysia. While the description is incomplete, we feel that the species is so distinct and recognisable, even in herbarium specimens, that it warrants formal description. The description can be further improved with additional material gathered in the future.

Hanguana malayana (Jack) Merr., Philipp. J. Sci., C, 10: 3 (1915). – *Veratrum malayanum* Jack, Malayan Misc. 1(1): 25 (1820). – *Veratronia malayana* (Jack) Miq., Fl. Ned. Ind. 3: 553. (1859). – *Susum malayanum* (Jack) Planch. ex Hook. f., Fl. Brit. India 6: 391 (1892). – TYPE: Malaysia, Pulau Pinang ["Poeloe Pinang"], *Jack s.n.* (not traced). (Fig. 11, 12)

Hanguana anthelminthica (Blume ex Roem. & Schult.) Masam., Enum. Phan. Born.: 81. (1942). — *Susum anthelminthicum* Blume ex Roem. & Schult., Syst. Veg. 7(2): 1493 (1830). — *Susum malayanum* f. *aquatica* Backer, Handb. Fl. Java 3: 3 (1924). — *Hanguana malayana* subsp. *anthelminthica* (Blume ex Roem. & Schult.) Backer, Bekn. Fl. Java 10(212): 2 (1949). — *Hanguana malayana* var. *anthelminthica* (Blume ex Roem. & Schult.) Bakh., Blumea 6: 399 (1950). – TYPE: Indonesia, Java "in paludibus circa Buitenzorg", *Blume s.n.* (lectotype L! [L2107638, L2107639; both sheets cross-referenced as being part of single gathering], here designated; isotype BO n.v. (as per Siti Nurfazilah et al., 2010).

Hanguana aquatica Kaneh., Trans. Nat. Hist. Soc. Formosa 25: 8 (1935). – TYPE: Caroline Islands, Palau, Almonogni, Babeldaob, 13 April 1938, *S. Hatusima* 4866 (holotype FU!).

Fig. 11. *Hanguana malayana* (Jack.) Merr. **A.** Habit. **B.** Branches with ripe fruits (inset: close-up detail of fruits and stigma). **C.** Infructescence. From plants cultivated at Singapore Botanic Gardens, *JLS-3033*. (Photos: Jana Leong-Škorničková)

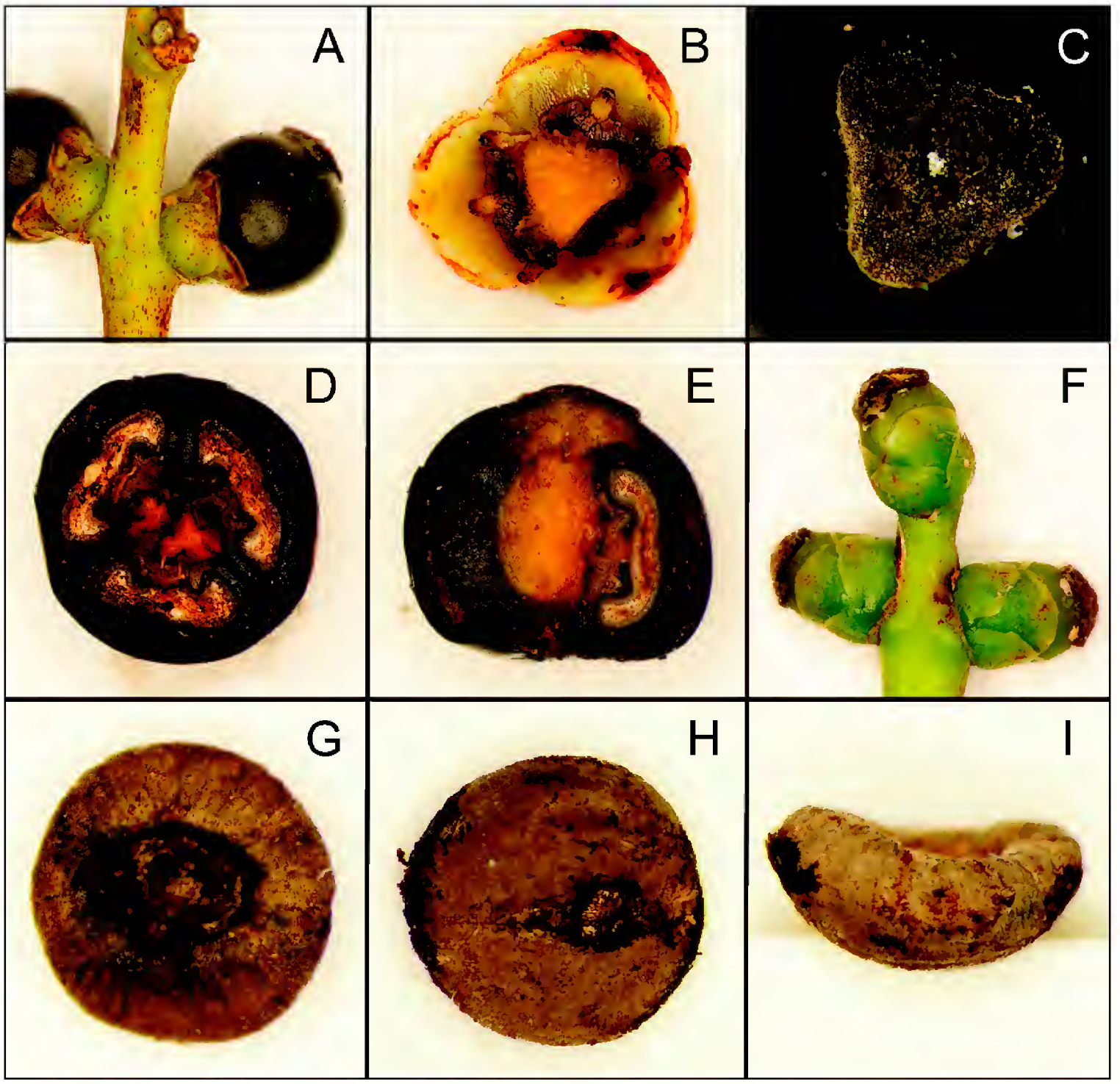

Fig. 12. *Hanguana malayana* (Jack.) Merr. **A.** Detail of tepals clasping base of ripe fruit (side view). **B.** Detail of inner tepals, staminodes and staminodial scales. **C.** Detail of stigma. **D.** Cross section of fruit showing three well-developed seeds. **E.** Longitudinal section of fruit. **F.** Detail of tepals clasping base of ovary (side view). **G.** Seed (top view). **H.** Seed (bottom view). **I.** Seed (lateral view). From plants cultivated at Singapore Botanic Gardens *JLS-3033*. (Photos: Jana Leong-Škorničková)

Notes: The identity of *Hanguana malayana* has been the subject of much debate, as the original material by Jack is still missing and Jack's original description, based on material from Pinang [Pulau Penang], although fairly long, does not offer many characters which could be considered species specific. The name has been uncritically applied to almost all forest species in Malaysia and Singapore since Backer's treatment of *Hanguana* for *Flora Malesiana* (Backer, 1951). The most recent attempt to clarify the identity and circumscription of *Hanguana malayana* is that of Siti Nurfazilah et al. (2010), who proposed that the name *H. malayana* should be applied to a widespread

large, helophytic, stoloniferous species. As this is the species which occurs in cultivation in Singapore (Fig. 11, 12), this current application is followed here with caution.

Hanguana malayana (sensu Siti Nurfazilah et al., 2010) is freely available in Singapore's nurseries and is occasionally used in landscaping. All herbarium records originating from Singapore, and previously identified as *Hanguana malayana*, at the K and SING herbaria (no specimens from Singapore exist at KEP), turned out to belong to the four species above treated. Our field explorations have so far not confirmed the presence of any populations which could be considered to be wild, although populations of *Hanguana malayana* have been planted in various locations in Singapore where they thrive and may naturalise easily. There is also no confirmed herbarium record of *Hanguana malayana* from areas close to Singapore. A revision of all *Hanguana* herbarium sheets at K, KEP, P and SING revealed that there are no collections of *H. malayana* from Johor. All confirmed collections in Peninsular Malaysia were collected only in Perak, Selangor, Terengganu, and a single historical collection of *Griffith 6014* (K), collected in Malacca [Melaka], which is about 200 km from Singapore. We have located two collections of *Hanguana malayana* from Sumatra (Indonesia), of which *Yates 2281* (P, 4x) is from Medan (c. 600 km from Singapore), while Zollinger's undated collection is without precise locality. Considering the above, there is, therefore, no reliable evidence, historical or recent, which would support the theory that *Hanguana malayana* was ever native to Singapore.

Conclusion

Recent discoveries of six native species new to science in heavily urbanised Singapore (including *Hanguana rubinea* and *H. triangulata* described above; *H. neglecta* – Niissalo et al., 2014; *Zingiber singapurense* Škorničk. – Leong-Škorničková et al., 2014; two *Utania* species – Sugumaran & Wong, 2014), serves to remind us of several important points. Firstly, that although Singapore is the most densely collected country in SE Asia and its primary vegetation has been severely disturbed, the process of documenting and fully understanding its rich biodiversity is incomplete. Secondly, that while herbarium-based taxonomy is sufficient in some plant groups, satisfactory progress on others without observation of fertile material in the field is almost impossible (for example in Zingiberaceae and Hanguanaceae). And lastly, that such field-based knowledge can lead to the discovery of previously overlooked characters, in this case the staminodial scales and the seed structure, which can then be applied to the identification of existing herbarium collections.

A poor understanding of the genus *Hanguana* in Singapore and the misapplication of the name *Hanguana malayana*, which was previously treated as Vulnerable in the Singapore Red Data Book (Davison et al., 2008), obviously has implications for conservation of all four native species. These four species are all currently considered to be Endangered or Critically Endangered locally, and those endemic to Singapore also globally (*H. neglecta* EN/VU, *H. nitens* CR/LC, *H. rubinea* CR/CR and *H. triangulata* CR/CR). Further conservation work, including the observation of

pollinators and dispersal agents and the DNA barcoding of native species is planned. Also, now that the hidden diversity of *Hanguana* in Singapore has been recognised, *in situ* and *ex situ* conservation and propagation efforts for this interesting yet extremely neglected plant family in Singapore is underway. Due to the lack of any records suggesting that the large stoloniferous helophytic species, currently called *Hanguana malayana*, was ever native to Singapore, we recommend that this species be treated as not native to Singapore.

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Dischidia acutifolia (Apocynaceae, Asclepiadoideae) a new record for the Singapore flora

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ABSTRACT. We report the discovery of *Dischidia acutifolia* Maingay ex Hook.f., a new record for the Singapore flora. The species is only known from a single locality in Sungei Buloh Wetland Reserve and is therefore considered Critically Endangered in Singapore. A lectotype for the name is selected.

Keywords. IUCN Red Lists, Sungei Buloh Wetland Reserve

Introduction

In Singapore there are ten native species of *Dischidia* R.Br. (Chong et al., 2009; Rodda et al., 2012). Five of these are considered nationally extinct and one, *Dischidia singaporensis* Ridl., is considered a globally extinct species. A general introduction to the genus *Dischidia* can be found in various recent local treatments (Rintz, 1980; Li et al., 1995; Forster et al., 1996; Jagtap & Singh, 1999; Livshultz et al., 2005) while information on the local Singapore species is provided in Rodda et al. (2012). In September 2013 Desmond Lee and Mishak Shunari found an unidentified *Dischidia* growing at the base of the trunk of *Talipariti tiliaceum* (L.) Fryxell in Sungei Buloh Wetland Reserve. A small sterile cutting was brought to the Singapore Herbarium for identification. The cutting was incorporated into the Singapore Botanic Gardens' Research Living Collections where it rooted and soon after started flowering before producing any new growth. It was then identified as *Dischidia acutifolia*, a species rather common from Thailand to the Moluccas (Rintz, 1980). The species is not in the most recent checklist of Singapore's vascular plant flora (Chong et al., 2009) and no specimens collected in Singapore have previously been deposited in SING. We therefore here report it as a new record for the Singapore flora.

We can speculate that the Singapore plant may originate from a recent colonisation from seeds wind-dispersed from the coastal mangroves in Johore (Malaysia). However it is equally likely that the species, an epiphyte often growing high up in the tree canopy and bearing inconspicuous flowers, may have always been part of the Singapore flora but was never previously collected.

Conservation considerations

The species is only known from a single collection and is, therefore, to be considered Critically Endangered in Singapore, according to guidelines given in *The Singapore Red Data Book* (Davison, 2008). The original plant observed in 2013 was negatively affected by the drought in early 2014 (Ziegler et al., 2014), and the recovery has been slow (Lee and Mishak, personal observation). In contrast, the clone is very vigorous in cultivation and is being mass propagated at the Singapore Botanic Gardens (SBG acc. no. 20132480). Stock will soon be released for reintroduction trials.

The morphological description below is based on the specimen collected in Singapore. Measurements from cultivated materials are indicated in parentheses when they are significantly different from wild material.

Taxonomy

Dischidia acutifolia Maingay ex Hook.f., Fl. Brit. India 4(10): 51 (1883). – TYPE: Peninsular Malaysia, Malacca, 30 Oct 1865 or 6, *Maingay, A.C. 1960* (*Kew distribution number 1122*) (lectotype K, designated here [K000911032]). (Fig. 1)

Plants succulent, herbaceous, glabrous; epiphytic or hemi-epiphytic vines growing loosely rooted on the host tree stems, clinging by adventitious roots, rarely pendulous. Latex white. ***Roots*** on mature plants adventitious, produced at the node, along the internodes and just below each node, where they are sometimes paired. ***Leafy stems*** terete, up to 2.5 mm diameter, dark green; internodes (2–)5–20(–25) cm long. ***Leaves*** opposite, petiolate; petiole cylindrical, slightly flattened above, 4–7 mm long, 1.5–2 mm in diameter; lamina dark green, underneath lighter green with darker midrib and margin, fleshy, stiff (less so in cultivation), lanceolate, 4–7 × 1.5–4 cm (to 10 × 5 cm in cultivation); apex acute-apiculate, base (round) acute, margin entire, midrib and secondary veins slightly raised on adaxial surface, secondary veins 3–6 pairs, branching at 35–60° from midrib. ***Inflorescences*** usually bearing a single open flower at a time (up to 5 in cultivation) and 2–4 developing buds; peduncle extra-axillary or apparently axillary when borne on very short shoots, persistent, rachis one or two per peduncle, bearing scars of previous flowerings 2–5 mm long, 2–2.5 mm in diameter (to 2 cm long in cultivation); pedicels 0.6–0.8 mm long, c. 0.6 mm in diameter. ***Calyx*** c. 2 mm in diameter, green, lobes (round) ovate 0.6–0.8 × 0.5–0.8 mm, apex round, sparsely ciliate. ***Calycine colleter*** 1 or 2 at each calyx lobe sinus, ovate, with a round apex, 100–120 × 80–100 μm. ***Corolla*** succulent, urceolate, 3.5–4 × 2–2.5 mm, basally lighter yellow, progressively fading into light pink or white at the lobe apices, externally glabrous, corolla throat with one ring of retrorse hairs; lobes triangular, 0.5–0.7 × c. 0.6 mm, apex acute. Corolline corona absent. ***Staminal corona*** lobes 1.5–1.7 mm high, c. 1.5 mm in diameter, composed of five light yellow appendages shaped like an inverted anchor with a stipe and lunate apex. ***Style head*** conical, hidden by the anther appendages. ***Pollinarium*** erect, 550–600 × 500–600 μm with two oblong

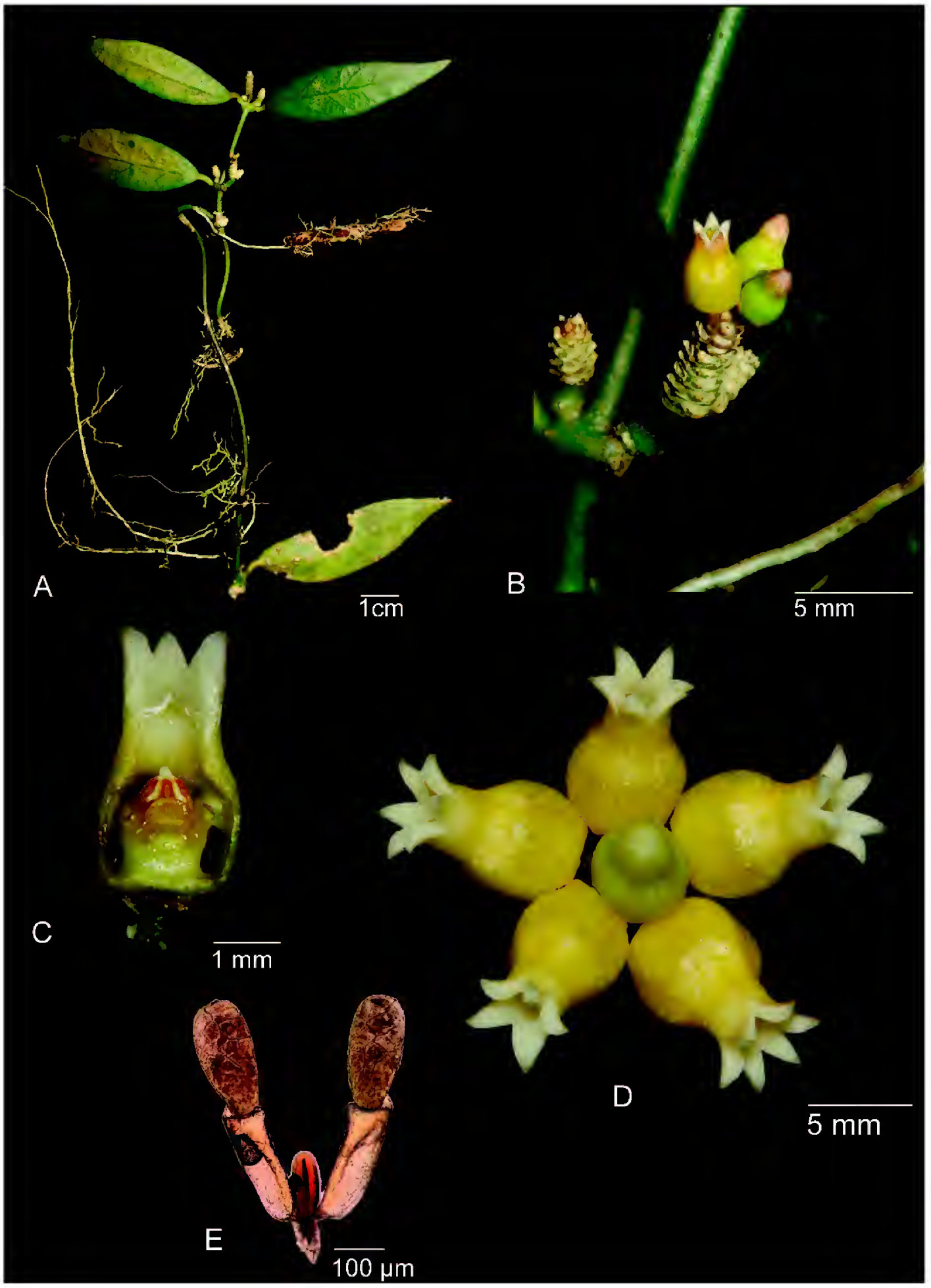

Fig. 1. *Dischidia acutifolia* in Singapore. **A.** The original plant as collected by Lee and Mishak in Sungei Buloh Wetland Reserve in 2013. **B.** First flowering in cultivation at SBG. **C.** Dissected flower. The single ring of hairs lining the corolla throat, the yellow corona appendages and the anther appendages covering the stigma head can be observed. **D.** Inflorescence with five open flowers; usually in wild-collected plants the inflorescences have only one open flower at a time. **E.** Pollinarium with twin pollinia. B–E Based on living plants cultivated at the Singapore Botanic Gardens (SBG acc. no. 20132480). (Photos: M. Rodda)

pollinia, 230–250 × 90–100 μm, apex and base rounded to obtuse, retinaculum 170–190 × 60–70 μm, caudicles elongated, laterally crested, 250–270 μm long. ***Ovary*** bicarpellate, bottle-shaped, 1–1.5 mm long, each carpel c. 0.7 mm in basal diameter. Fruits and seeds not seen.

Singapore specimens examined. Sungei Buloh Wetland Reserve, *Lee, D. & Shunari, M. s.n.*, cultivated at the Singapore Botanic Gardens, vouchered on 30 Oct 2014 as *Rodda, M. MR898* (SING, K, KEP).

Notes. The description of *Dischidia acutifolia* by Hooker (1883) was based on the collection *Maingay* (*Kew Distrib. 1122*). The herbarium of a particular specimen was not indicated. In Kew there is a specimen labelled as *Kew distribution number 1122* which is also labelled with the Maingay numbering series (*Maingay 1960*). An exhaustive search for duplicates has not been carried out but since the K specimen is not labelled as a unicate it is possible that duplicates may be found in other herbaria holding Maingay materials (B, BM, CAL, CGE-B, G, L [Steenis-Kruseman, 1950]). Therefore a lectotype needs to be selected. The K specimen is well preserved and matches the description of *Dischidia acutifolia* and is therefore selected as lectotype for the name.

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From *Ancistrocladus* to *Tristaniopsis* via *Tetramerista* - the convoluted history of a Wallich collection and its impact on the native flora of Singapore

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ABSTRACT. *Ancistrocladus sagittatus* Wall. ex Planch. (Ancistrocladaceae) is the name of a plant species solely based on a sterile collection made by Nathaniel Wallich in Singapore in 1822. Since 1875, this name has been treated as a variety or synonym of *Tetramerista glabra* Miq. (Tetrameristaceae). However, the original material is actually referable to *Tristaniopsis* (Myrtaceae), and *Ancistrocladus sagittatus* is here lectotypified and reported as a synonym of *Tristaniopsis merguensis* (Griff.) Peter G.Wilson & J.T.Waterh. for the first time. The new determination of the Wallich collection means that the record of *Tetramerista glabra* in the native flora of Singapore requires reassessment. It is concluded that *Tetramerista glabra*, the genus *Tetramerista* and the family Tetrameristaceae should all be excluded from inventories of the native flora of Singapore.

Keywords. *Ancistrocladus*, flora, Singapore, synonymy, *Tetramerista*, *Tristaniopsis*, typification

Introduction

Nathaniel Wallich (1786–1854) was a Danish surgeon who studied botany in Copenhagen. In 1807, he arrived at Serampore in India to work as a medical doctor. By 1814 he had officially joined the British East India Company, still working in the medical service, and in 1815 he was appointed Superintendent of the Botanic Garden in Calcutta. Wallich undertook various expeditions to collect specimens. This included a trip from Calcutta to Penang and Singapore in 1822. Of the many collections made by Wallich and his assistants on this trip, one from Singapore, of apparently only sterile material, was named *Ancistrocladus sagittatus* by Wallich. The name was included as number 1055 in Wallich's monumental listing of the East India Company Herbarium known as the *Numerical List* (Wallich, 1828–1849) or Wallich's Catalogue. As with the vast majority of plant names in the *Numerical List*, *Ancistrocladus sagittatus* was a *nomen nudum* in the absence of a description or reference to a published one. An exception to this rule was actually provided by the generic name *Ancistrocladus*. This was validly published in the *Numerical List* as a replacement name for *Wormia* Vahl, a later homonym of *Wormia* Rottb. (Dilleniaceae). The top set of the East India Company collections was maintained as a closed collection, often referred to as the Wallich Herbarium, firstly at the Linnean Society of London and later, from 1913, at

the Royal Botanic Gardens Kew (K-W). Other material was distributed by Wallich under the list numbers to many different individuals, including William Hooker, and institutions, though it should not be assumed that all specimens with the same number represent true duplicates.

Ancistrocladus sagittatus was first validated by the French botanist Jules Émile Planchon in a paper on *Ancistrocladus* (Planchon, 1849). Planchon based the species solely on Wallich's collection, but did not state which specimens he had seen. Planchon worked as assistant to William Hooker at Kew in the period 1844–1848 and, for several other *Ancistrocladus* species in his revision, he indicated that he had seen specimens in Hooker's personal herbarium. I therefore designate a specimen distributed under the East India Company number 1055, now in the general herbarium of the Royal Botanic Gardens Kew and formerly in Hooker's personal herbarium, as the lectotype of *Ancistrocladus sagittatus* Wall. ex Planch.

Alfred William Bennett seems to have been the first to realise that *Ancistrocladus sagittatus* did not belong in *Ancistrocladus*. In the account of the Ochnaceae for the *Flora of British India*, Bennett (1875) treated *Ancistrocladus sagittatus* as a variety of *Tetramerista glabra* Miq. (Tetrameristaceae, formerly placed in the Ochnaceae or Theaceae). A casual encounter with this piqued my interest because, if this reduction were taxonomically correct, then *Ancistrocladus sagittatus*, the older of the two names, should provide the correct epithet at the rank of species. The treatment of *Ancistrocladus sagittatus* as a synonym of *Tetramerista glabra* has been repeated in subsequent revisions of *Ancistrocladus* (Steenis, 1948; Gereau, 1997; Taylor et al., 2005) and *Tetramerista* (Lim, 2010).

The online catalogue of the Kew Herbarium made it easy to discover that the recent determinations of the Wallich specimen in the general herbarium were under the myrtaceous genus *Tristaniopsis* (formerly *Tristania*) rather than *Tetramerista*. The two genera bear superficially similar foliage. However, *Tetramerista* lacks a clear intramarginal nerve (Keng, 1989), which is evident in the Wallich specimens at Kew, leading me to agree with the placement in *Tristaniopsis*. Following the treatment of *Tristaniopsis* by Ashton (2005, 2011), I therefore consider *Ancistrocladus sagittatus* to be a new synonym of *Tristaniopsis merguensis* Griff.

Tristaniopsis merguensis (Griff.) Peter G.Wilson & J.T.Waterh., Austral. J. Bot. 30: 439 (1982). – *Tristania merguensis* Griff., Account Bot. Coll. Cantor 18 (1844–1845). TYPE: Burma, Mergui, *W. Griffith 235* (isotypes K [barcode nos. K000793713, K000793713]).

Ancistrocladus sagittatus Wall. [Numer. List no. 1055 (1829), nom. nud.] ex Planch., Ann. Sci. Nat., Bot. sér. 3, 13: 319 (1849), **synon. nov**. – *Tetramerista glabra* Miq. var. *sagittata* (Wall. ex Planch.) A.W.Benn. in Hook.f., Fl. Brit. India 1: 526 (1875). TYPE: Singapore, 1822, *N. Wallich s.n.* [EIC 1055] (lectotype K [barcode no. K000793725], designated here; isolectotypes K-W [barcode nos. K001110861, K001110862]).

As well as dealing with the correct placement of the name *Ancistrocladus sagittatus*, this finding also brings into question the occurrence of *Tetramerista glabra* in Singapore. The species has been listed in the Singapore flora (Ridley, 1900; Keng, 1990) based solely on the Wallich record which we now know to be an error of identification. The work of Corner (1978) on the swamp forests of Johore and Singapore supports the absence of *Tetramerista glabra* from Singapore. He found the species in the true peat swamp relict at Pontian in Johore, but not in the freshwater swamps in the Sedili forests of Johore or Singapore. I therefore consider that there is no record of *Tetramerista glabra* from Singapore and the species, genus and family all have to be removed from listings of the native flora until evidence to the contrary is forthcoming.

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The clarification and synonymisation of two taxa of *Vittaria* from Peninsular Malaysia and a new combination in *Haplopteris* (Pteridaceae subfam. Vittarioideae)

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ABSTRACT. A variety and a species of *Vittaria* in Peninsular Malaysia are synonymised and the new combination *Haplopteris sessilifrons* (Miyamoto & H.Ohba) S.Linds. is made.

Keywords. Adiantaceae, *Haplopteris sessilifrons*, *Vittaria ensiformis* var. *latifolia*, *Vittaria sessilifrons,* Vittariaceae

Introduction

As research towards an account of Adiantaceae for the *Flora of Peninsular Malaysia* is progressing, papers are being published to clarify the correct generic placement of a number of species (Lindsay, 2010; Lindsay & Chen, 2014). Wider discussions on the current delimitation of the Asian genera formerly placed in the family Vittariaceae (most often treated as part of Pteridaceae subfam. Vittarioideae but to be included in Adiantaceae for the *Flora of Peninsular Malaysia*) can be found in Crane (1998), Lindsay (2004), Ruhfel et al. (2008) and Lindsay & Chen (2014).

This current paper concerns a species described by Miyamoto & Ohba (1992), *Vittaria sessilifrons* Miyamoto & H.Ohba, and a variety written about by Holttum (1955), *Vittaria ensiformis* var. *latifolia*.

Miyamoto & Ohba (1992) described *Vittaria sessilifrons* based on several of their own collections from Pahang in Peninsular Malaysia. We had been unable to locate any of the isotypes or paratypes, said to be in a number of herbaria, until it was discovered that none of the type material had been distributed. This has now been rectified and SING herbarium received an isotype and two paratypes in 2014. Examination of this material has revealed it to be the same taxon previously written about as *Vittaria ensiformis* var. *latifolia* by Holttum (1955). Unfortunately, Holttum's variety was not validly published due to the lack of a Latin diagnosis or description (Art. 39.1; McNeill et al. 2012).

We had earlier delayed making a decision on what to do with the material referable to *Vittaria ensiformis* var. *latifolia*, due to its apparent intermediate position

between *Haplopteris ensiformis* (Sw.) E.H.Crane and *H. elongata* (Sw.) E.H.Crane (formerly *Vittaria ensiformis* Sw. and *V. elongata* Sw.). Until the additional three specimens were received from Japan, we had seen only five specimens that could be referred to this taxon (three annotated by Holttum plus two others: *Mohd Shah & Samsuri MS3822* (SING) and *R. Kiew RK1989* (KEP)). We remained unsure as to whether it blurred the distinction between *Haplopteris ensiformis* and *H. elongata*, whether it should be described as a variety of one or the other (but leaning towards *H. elongata*), or whether it should be described as a new species (before we discovered that it was already described as *Vittaria sessilifrons*). Holttum (1955) made it a variety of *Vittaria ensiformis*, based on its sessile fronds, but noted its similarities to *V. elongata*. Miyamoto & Ohba (1992), however, compared their new species to *Vittaria elongata* and *V. scolopendrina* (Bory) Schkuhr ex Thwaites & Hook. (now *Haplopteris scolopendrina* (Bory) C.Presl) although noted it 'differs greatly' from the latter.

With the availability of more material, now covering a broader geographical distribution in Peninsular Malaysia, it has become clear that the characters which define this taxon are quite stable and that Miyamoto & Ohba (1992) were quite correct to describe it at the rank of species. It is similar to *Haplopteris ensiformis* in having sessile fronds and sori in deep marginal or submarginal grooves but differs in having a distinct costa above (at least in the lower half of the frond) and a wider and thinner lamina in which the lateral veins are visible (at least with transmitted light). It is similar to *Haplopteris elongata* in the width and texture of the lamina, the visibility of the venation and the position and structure of the sori, but differs in having sessile fronds and costae that are more strongly raised above (the costae of *H. elongata* are usually distinct but flat or hardly raised above). It is similar to *Haplopteris scolopendrina* in the texture of the lamina and the visibility of the venation but differs in having much narrower and shorter fronds and sori in deep marginal or submarginal grooves (the sori of *H. scolopendrina* are in shallow and broad submarginal grooves).

Based on the arguments to be found in Crane (1998) and Lindsay (2004), *Vittaria sessilifrons* now requires a combination in *Haplopteris* which is here provided.

New combination

Haplopteris sessilifrons (Miyamoto & H.Ohba) S.Linds., **comb. nov.** – *Vittaria sessilifrons* Miyamoto & H.Ohba, Acta Phytotax. Geobot. 43(1): 33, f. 2 (1992). – TYPE: Peninsular Malaysia, Pahang, Gunung Tahan, Sungai Luis, alt. 700 m, 19 March 1990, *Ohba, H. & Miyamoto, F. 900536* (holotype TI!; isotypes FRI, L, US, SING!).

Vittaria ensiformis var. *latifolia* Holttum, Rev. Fl. Malaya 2: 614 (1955 ['1954']), nom. inval.

Epiphytic or lithopyhtic. ***Rhizome*** short-creeping, usually obscured by a mass of extremely hairy roots, c. 1–2 mm diameter (in the dry state), bearing fronds close

together, densely scaly. ***Scales*** linear, stiff, straight, gradually narrowing from a cordate base towards a long-tailed and ultimately filiform apex, up to c. 6 mm long and c. 0.7 mm wide (at base), clathrate, sparsely toothed at margin particularly near base and somewhat bicoloured, the walls of the inner cells being thicker and darker than those of the outer cells (most noticeable in the section of the tail that is two cells wide; the common wall in the middle is thick and black while the two marginal walls are thinner and somewhat red). ***Fronds*** pendulous, simple, linear, 9–40 cm long, 0.45–1.3 cm wide, gradually narrowing towards both ends, the apex narrowly acute, the base sessile. ***Lamina*** coriaceous, glabrous, the margins revolute almost the entire length of the frond, midrib and margins moderately to strongly raised on the upper surface particularly in the lower half of the frond, the midrib usually becoming flatter towards the frond apex but the margins remaining raised throughout, midrib flat and indistinct below. ***Lateral veins*** more-or-less visible from above (or with transmitted light), indistinct below, simple, very oblique, parallel, joined by a continuous submarginal vein. ***Sori*** very long, linear, uninterrupted, appearing to be marginal (but actually arising from the submarginal vein), in a deep, two-lipped, groove in the revolute frond margin (therefore only visible from below), the two lips more-or-less equal. ***Sporangia*** with annuli composed of 16–18 cells. ***Soral paraphyses*** copious, their stalks multicellular, filiform, mostly colourless; their apical cells large, funnelform, twice as long as wide or longer, reddish-brown. ***Structures resembling sporangial stalks*** (but without sporangia attached) more numerous than paraphyses. ***Spores*** bilateral, bean-shaped, monolete, pale, translucent, smooth.

Distribution. Peninsular Malaysia and, possibly, Borneo. We have seen specimens from Johor, Negeri Sembilan, Pahang and Terengganu (close to the border with Kelantan) in Peninsular Malaysia. Holttum (1955) lists Perak too. We have not verified material from Borneo listed as *Vittaria ensiformis* var. *latifolia* in online herbarium specimen databases.

Ecology. Information is scant. However, three collections are described as epiphytic on mossy tree-trunks near streams in forests, one as epiphytic 3 m from the ground above a river, and one as growing on rocks. The lowest recorded altitude is 200 m and the highest is 762 m.

Provisional IUCN conservation assessment. Data Deficient (DD). Although not often collected, this species is widespread in Peninsular Malaysia which would suggest an assessment of Least Concern. However, of the collections known, several are more than 100 years old and none have been collected since 1990.

Additional specimens examined. PENINSULAR MALAYSIA: **Johor:** Kota Tinggi, [locality illegible], 1910 [month illegible], *Ridley, H.N. s.n.* (SING [SING0033264]); Mount Austin, [1901?; date illegible], *Ridley, H.N. s.n.* (SING [SING0085661]); Sungai Salat, Ulu Endau, Sep 1985, *Kiew, R. RK1989* (KEP). **Negeri Sembilan:** Gunung Angsi, alt., 2500 ft. [762 m], 22 Nov 1923., *Nur, Md SFN11617* (SING). **Pahang:** Gunung Tahan, Sungai Juram, alt. 200 m, 11

Mar 1990, *Ohba, H. & Miyamoto, F. 900120* (SING, TI); Sungai Juram to Sungai Luis, alt. 700 m, 13 Mar 1990, *Ohba, H. & Miyamoto, F. 900208* (SING, TI). **Terengganu:** Gunung Ayam via Ulu Besut, alt. 2,400 ft. [732 m], 5 Mar 1976, *Shah, Mohd & Samsuri MS3822* (SING).

Notes. The holotype and SING isotype are clearly labelled as having been collected on 19 March 1990; the date in the protologue of 13 March 1990 is a printing error.

In his key to the Malayan species of *Vittaria*, Holttum (1955: 608) says of *Vittaria ensiformis* var. *latifolia* that the "midrib [is] never strongly raised on [the] upper surface". This statement is at odds with the protologue of *Vittaria sessilifrons* which says "costa and margin raised on upper side" and illustrates both as being rather strongly raised (see Miyamoto & Ohba, 1992, Fig. 2E & G). We have examined three specimens annotated by Holttum and, in each, the costa and margins are moderately to strongly raised on the upper surface of the basal half of the frond.

Miyamoto & Ohba (1992) state that *Vittaria sessilifrons* differs greatly from *V. scolopendrina* in having a raised costa. This implies that *Haplopteris scolopendrina*, using the current name, does not have a raised costa when in reality it does. The costa of *Haplopteris scolopendrina* is, in fact, very strongly raised on the upper surface of the frond (even more so than in *Haplopteris sessilifrons*) for almost the entire length of the frond.

The illustration of the paraphyses in the protologue of *Vittaria sessilifrons* shows them with ovoid or clavate heads but we have not seen any paraphyses of this sort in the type material or in any other material. Instead, all material that we have examined has paraphyses with funnelform apical cells, a shape that is typical for *Haplopteris*. As well as these paraphyses, all of the specimens of *Haplopteris sessilifrons* have a very large number of structures that look like sporangial stalks without sporangia attached. It is unclear whether these are an artefact of dried specimens or if, as we suspect, these develop without ever producing sporangia. Similar structures are sometimes found in both *Haplopteris elongata* and *H. ensiformis* but never so densely.

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Bothriospermum (Boraginaceae), a new generic record for the Flora of Peninsular Malaysia

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ABSTRACT. *Bothriospermum zeylanicum* (J.Jacq.) Druce (Boraginaceae), a species native to Asia, has recently become naturalised in Cameron Highlands, Pahang, Malaysia. A description of the genus and species together with colour photographs are provided. It is the only representative of Boraginaceae *sensu stricto* (i.e. subfam. Boraginoideae) in Peninsular Malaysia.

Keywords. Boraginaceae, *Bothriospermum*, naturalised weed, new genus record, taxonomy, Malaysia

Introduction

In 2007 a fieldtrip to Cameron Highlands, Pahang, Peninsular Malaysia led to the discovery of a species of Boraginaceae that was tentatively identified as a *Myosotis*, a genus not otherwise recorded from Peninsular Malaysia. Realising it was something new, a second fieldtrip was organised in April 2014 to obtain more material and to take photographs so that it could be correctly identified. It proved to be *Bothriospermum zeylanicum*, which is a new record for the genus and species for Peninsular Malaysia; the genus is not recorded in either the *Flora Malesiana* revision of the Boraginaceae (Riedl, 1997), nor in the checklist by Turner (1997). New weeds, often of temperate species, are regularly introduced into the Cameron Highlands, where extensive vegetable and flower farms have replaced the lower montane forest. For example, Kiew (2009) recently reported 17 new records of naturalised weed species, of which ten were from Cameron Highlands. Interestingly, *Bothriospermum zeylanicum* occurs at a lower altitude (c. 1200 m) than most of these other weeds. A full morphological description of the genus and species, together with colour photographs, is provided here.

Turner (1997), in his catalogue of Peninsular Malaysian plants, listed under Boraginaceae 16 species in 9 genera: *Argusia* (1 species), *Carmona* (1 species), *Coldenia* (1 species), *Cordia* (4 species), *Ehretia* (4 species), *Heliotropium* (1 species), *Pteleocarpa* (1 species), *Rotula* (1 species) and *Tournefortia* (2 species). Recent molecular work by Refulio-Rodriguez & Olmstead (2014) separated *Cordia* and *Coldenia* into Cordiaceae; *Ehretia*, which now includes *Carmona* and *Rotula* (Gottschling et al., 2014), into Ehretiaceae; and *Argusia*, *Heliotropium* and *Tournefortia*

into Heliotropiaceae. *Pteleocarpa* is now placed in Gelsemiaceae (Struwe et al., 2014). In other words, all the genera listed by Turner under Boraginaceae have been assigned to other families meaning that now the Boraginaceae s.s. is represented in Malaysia only by this new record, *Bothriospermum zeylanicum*. Even if the narrow family circumscription adopted by Refulio-Rodriguez & Olmstead (2014) is not followed and one prefers to recognise Cordiaceae, Ehretiaceae and Heliotropiaceae as subfamilies Cordioideae, Ehretioideae and Heliotropoideae (e.g. Engler & Prantl, 1897; APG III, 2009), it remains true that *Bothriospermum zeylanicum* is the only Malaysian representative of the type subfamily Boraginoideae.

Taxonomic treatment

Bothriospermum Bunge, Enum. Pl. China 47 (1833); Clarke, Fl. Brit. India 4: 167 (1885); Backer & Bakhuizen *f.*, Fl. Java 2: 463 (1965); Zhu et al., Fl. China 16: 418 (1995); Riedl, Fl. Malesiana ser. I, Spermat. 13: 63 (1997); Hsiao & Liu, Fl. Taiwan 4: 387 (1998). – TYPE: *Bothriospermum chinense* Bunge.

Annual or biennial herbs, hispid or pubescent. ***Stems*** erect or prostrate. ***Leaves*** spirally arranged; lamina elliptic, ovate or oblanceolate, margin entire. ***Flowers*** extra-axillary, small, solitary but often forming a leafy raceme in distal part of the branches, distinctly pedicellate; calyx 5-lobed, the lobes divided to the base, narrowly lanceolate, slightly enlarged in fruit; corolla blue or white, rotate, tube short, lobes 5, spreading, obtuse, 5 small scale-like appendages present in the throat. ***Stamens*** included in the corolla, filaments very short, anthers 5, ovoid. ***Ovary*** deeply 4-lobed, style short, persistent, stigma small, capitate; gynobase flat. ***Fruits***: nutlets 4, very small, erect, ellipsoid or subglobose attached to the flat or nearly flat receptacle, surface usually sculptured, ventral side with a large aperture surrounded by prominent margin.

Distribution. About 5 species, distributed in Afghanistan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, Russia, Pakistan, India, China (its centre of distribution), Japan, Korea, Taiwan, Vietnam and the Philippines; naturalised in Indonesia (Java).

Bothriospermum zeylanicum (J.Jacq.) Druce, Bot. Exch. Club Brit. Isles 4: 610 (1917); Zhu et al., Fl. China 16: 419 (1995); Riedl, Fl. ser. I, Spermat. 13: 63 (1997); Hsiao & Liu, Fl. Taiwan 4: 388 (1998). – *Anchusa zeylanica* J.Jacq., Ecl. Pl. Rar. 1(3): 47, t. 29 (1812). – TYPE: Plate t. 29 in Jacquin, Ecl. Pl. Rar. 1(3) (1812). (Fig. 1 & 2)

Anchusa tenella Hornem., Hort. Bot. Hafn. 1: 176 (1813). – *Bothriospermum tenellum* (Hornem.) Fisch. & C.A.Mey., Index Sem. Hort. Petrop. 1: 23 (1835); Clarke, Fl. Brit. India 4: 168 (1885); Backer & Bakhuizen, f., Fl. Java 2: 463 (1965). – TYPE: *Herb. Vahl s.n.* 'Hab. in China' (holotype C *n.v.*).

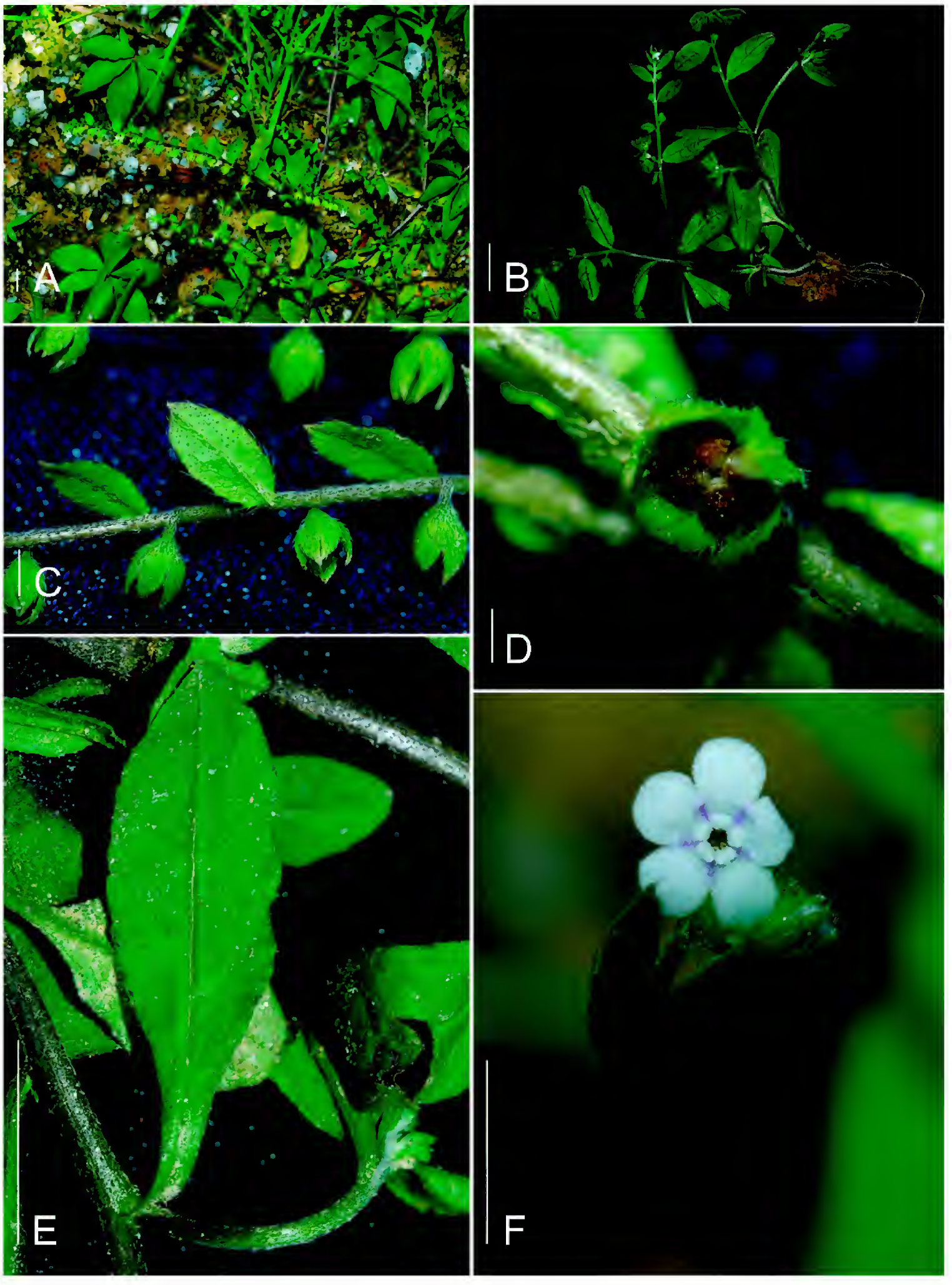

Fig. 1. *Bothriospermum zeylanicum* (J.Jacq.) Druce. **A–B.** Habit. **C.** Arrangement of flowers and fruits. **D.** Nutlet. **E.** Leaf. **F.** Flower. Scale bars: A, B, C (5 cm); D (1 mm); E (2 mm); F (5 mm). (Photos: A.R. Rafidah)

Fig. 2. Habitat of *Bothriospermum zeylanicum* (J.Jacq.) Druce. (Photo: A.R. Rafidah)

Short-lived herbs with prostrate stems. ***Stems*** slender, densely pubescent throughout, much branched, up to 50 cm long. ***Leaves***: petiole short, c. 5 mm long in lower leaves, lacking in the upper; lowermost laminas 20–30 × 6–10 mm, decreasing in size to 4–10 × 2–4 mm in the upper ones, elliptic to lanceolate, margin slightly undulate, densely strigose on both surfaces, base cuneate, midrib impressed above, prominent beneath, apex acute. ***Pedicels*** c. 2 mm long. ***Flowers***: calyx green, densely hairy outside; corolla white or very pale purple (in Peninsular Malaysia), c. 2 mm long, lobes 5, longer than the tube, c. 2 mm long, apex broadly rounded, throat appendages white, trapeziform, emarginate, c. 0.2 mm. ***Stamens*** 5, included, inserted at the middle of corolla tube, filaments short, anther yellowish turning brown. ***Ovary*** green, style less than 1 mm long, terete. ***Nutlets*** green turning brown, ellipsoid, to 1 mm long, aperture longitudinally elliptic, surface warty; calyx persistent, c. 3 mm long.

Distribution. As for the genus, in Peninsular Malaysia only from Cameron Highlands, Pahang.

Ecology. Growing in waste land on sandy soil or in open fields or near rivers, at c. 1200 m altitude.

Specimens examined. PENINSULAR MALAYSIA: **Pahang:** Cameron Highlands, Belati Estate, 4°27'N 101°28'E, 8 Oct 2007, *Kiew et al., FRI70433* (KEP), Kampung Terla, 4°31'N 101°23'E, 8 Oct 2007, *Kiew et al., FRI70473* (KEP), Habu, 4°26'N 101°23'E, 23 Apr 2014, *Rafidah et al., FRI75968* (KEP), Habu, 4°26'N 101°23'E, 23 Apr 2014, *Rafidah et al., FRI75969* (KEP).

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Novitates Bruneienses, 1. A background to the botanical survey of Brunei Darussalam, and a new species of *Jarandersonia* (Malvaceae)

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ABSTRACT. A brief introduction to research and botanical documentation of the Brunei flora, and the collaborative programme for a continuing botanical survey of the country, is given. An outline of the key biogeographical features of the Brunei area supports the premise that distinct geo-ecological enclaves occur which are special units of species richness, within which a significant level of undocumented plant diversity still exists. *Jarandersonia yahyantha* K.M.Wong, Joffre, Ariffin & Y.W.Low (Malvaceae), a new tree species so far only known in Brunei, is described.

Keywords. Biological hotspot, biogeography, Borneo, Malesia, new species, Southeast Asia

Introduction: The floristic richness of Borneo and Brunei Darussalam

This new series supports a recently established programme to further the botanical exploration of Brunei Darussalam, in northwestern Borneo, the third-largest island in the world and biologically the richest landmass of the Sundaland region (MacKinnon & MacKinnon, 1986; Ashton, 1989). The Malesian region as a whole (Malay Peninsula and Malay Archipelago, including the area from the Philippines through to New Guinea) has a diverse flora estimated to include 42,000 seed plant species (Roos, 1993). Myers et al. (2000) considered Sundaland, which includes the Malay Peninsula, Sumatra, Java and Borneo, one of tropical Southeast Asia's four biodiversity hotspots.

Estimates of the Bornean vascular flora have ranged from 9000 (Merrill, 1921) to 15,000 species (Merrill, 1950; Raes et al., 2009). However, although recent work completed by Beaman & Anderson (2004) enumerated more than 5000 vascular plant species in Kinabalu Park (Sabah) alone, further work has suggested that many more novelties were to be expected there (Chen et al., 2014), as well as generally with the *Tree Flora of Sabah and Sarawak* (e.g., Soepadmo & Wong, 1995 and further volumes). As such, Merrill's upper limit for Borneo, or a tally in excess of that, is to be expected. On the other hand, Brunei, with its land area of 5765 km^2 being less than a mere 1% of the whole of Borneo, was estimated to have close to 5000 species of

seed plants, including 2000 species of tree (Wong, 1997). A first intensive checklisting of the flora based on organised field collecting over some seven years, 1989–1995, much of it an active collaboration between the Brunei Forestry Department and the Royal Botanic Gardens, Kew (Coode et al., 1996), accounted for some 3500 species of indigenous seed plants, including 1900 tree species (Wong, 1999). Apart from the Dipterocarpaceae, which has been well treated by Ashton (1964, 1982) and is generally well collected, this checklist remains a first-stage investigation of the flora because (1) many families and genera still had significant numbers of undetermined specimens; (2) recent critical revisions were not available then for many genera; and (3) in the ensuing period the Brunei Herbarium continued to gather interesting taxa that had not been captured by earlier collecting effort. Thus it can be appreciated that the Brunei flora is a very rich one.

In 2013, the Government of His Majesty The Sultan of Brunei Darussalam and the National Parks Board, Singapore, entered into a collaborative programme for a new phase of botanical survey. This seeks to intensify fieldwork for biodiversity exploration and documentation, and to focus on the botanical inventory of Brunei, including taxonomic identifications by specialists from our own and outside institutions when possible.

Key biogeographical features of the Brunei area

In the same year as this new collaboration began, a review of the flowering plants endemic to Brunei was published (Henrot et al., 2013), listing 65 species of angiosperms hitherto known only from Brunei, and suggesting that, as with a number of other species generally occurring only in the Brunei area (which includes adjacent parts of SW Sabah or NE Sarawak), some of the so-called endemics could subsequently be found to be not so restricted. The latter category is exemplified by the aroids *Homalomena scutata* S.Y.Wong & P.C.Boyce, occurring in both the Belait and Temburong districts of Brunei but found also in the Limbang and Mulu areas in adjacent NE Sarawak (Wong & Boyce, 2014), and *H. cowleyae* P.C.Boyce & S.Y.Wong, known in the Temburong and Mulu areas (Boyce & Wong, 2014).

There are at least two biogeographic scenarios why this work on endemic plants is significant. One is that we could indeed expect there would be true Brunei endemics, as botanical experience has shown for, especially, herb species, including many *Begonia* or gesneriad taxa, as well as smaller plants in general. Henrot et al. (2013) found that most of the documented endemic taxa were smaller plants in the Begoniaceae (15 taxa), Araceae (8 taxa), Gesneriaceae (7 taxa), Orchidaceae (5 taxa), Zingiberaceae (5 taxa), and palms (Arecaceae: 5 taxa), so it could be true that many large flowering plants have better dispersal than small ones. Although it should be borne in mind that, thus far, the collecting and research effort has concentrated much on trees, rather than herbs, other reasons, including recent evolution, may restrict plant distribution. A slender bamboo, *Temburongia simplex* S.Dransf. & K.M.Wong, is the only known representative of this peculiar genus (Dransfield & Wong, 1996)

that is still entirely restricted to Brunei's Temburong valley, even after two decades of continuing botanical collecting in Borneo. There is a suite of similarly restricted *Begonia* and other species. Some others are borderline cases: for instance, the palm *Livistona exigua* Dransf., documented from Brunei's Batu Patam ridge, still has not been documented from adjacent parts in Sarawak.

Wong (1997, 1999) discussed how the Brunei area includes its own geographical and ecological enclaves within the geologically distinct (but relatively youthful) and larger northwest Borneo area, taking into consideration how its main area is hemmed in by either highlands (such as around inland Temburong, Tutong and Belait) or extensive swamp systems (as in the lower Belait and Baram drainage complex to its southwest) (Fig. 1). The western side of Brunei is largely the remains of an ancient syncline, now drained by the Belait and Tutong rivers, whereas the eastern Temburong district is mostly the drainage area of one major river system, the Temburong (Ashton, 1958). This, together with precipitous topography marked by steeply incised valleys in the hard sandstones of inner Temburong, or in the uppermost reaches of the Belait and Tutong, can conceivably bring about population isolation that engenders highly localised endemism (Coyne & Orr, 2004). Even in the Belait district, where topographic relief is generally lower than in the Temburong, hilly pockets isolated by swamps or river systems, or highly specific habitats such as moist sandstone bluffs, may harbour narrowly endemic or habitat-specialist taxa, such as *Homalomena* spp. documented only from the Teraja area of Belait (Wong & Boyce, 2011). Many of the flowering plants endemic to Brunei Darussalam are either very rare or undercollected: 15 are known from a single collection only and 83% are known from three sites or fewer.

The other significant dimension is that Brunei has maintained maximal levels of forest cover within the country (Bryan et al., 2013). Borneo's forest cover declined from 71% of the island (mid-1980s) to 54% by 2000, an alarming rate of deforestation (Stibig & Malingreau, 2003). With continuing rainforest degradation in the region, Brunei Darussalam could continue to serve as a critical refuge for Bornean plants impacted by such processes. Henrot et al. (2013) discussed the increasing importance of 'anthropogenic endemics' in refuge in Brunei from the wider Brunei area or beyond: it is a scenario we would not wish to see exacerbated, but the significance of conserved resources in Brunei becomes obvious. In upping the ante, the Brunei Ministry of Industry and Primary Resources phased out logging in all Forest Reserves (previously some had been classified for timber production) in 2014 (Brunei Times, 2014).

Continuing efforts

All this underscores how important it is now for authorities in Borneo to redouble efforts into biodiversity inventory and conservation planning, in order that as many specially diverse or unique areas as possible can be recognised in time and be brought under effective management. For our part, it brings us back to the special collaboration now in place between the Brunei National Herbarium (acronym BRUN; Thiers, continuously updated) and the Singapore Herbarium (SING), and their partner institutions, for continuing the Botanical Survey of Brunei Darussalam.

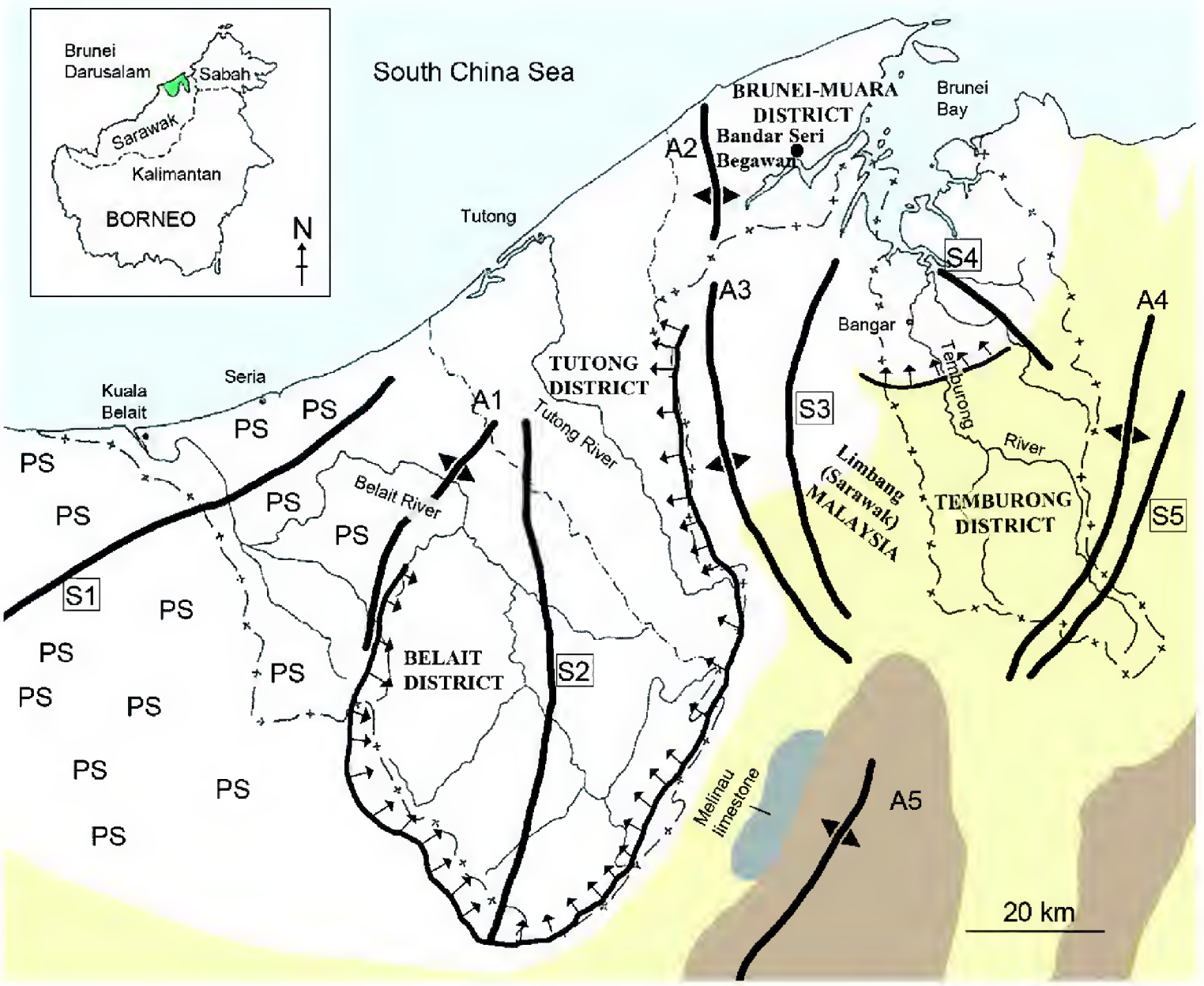

Fig. 1. The Brunei area: Key geological, tectonic and topographical features.
Uncoloured: Pliocene - Miocene Sediments, in places overlain by Pleistocene or more recent deposits. *Yellow*: Miocene - Oligocene Sediments. *Brown*: Rajang Group Deepwater Sediments (Late Cretaceous - Eocene). *Anticlines*: **A1.** Belait anticline. **A2.** Jerudong anticline. **A3.** Danau anticline. **A4.** Tangga anticline. **A5.** Mulu Uplift. *Synclines*: **S1.** Liku-Badas syncline. **S2.** Belait syncline. **S3.** Limbang syncline. **S4.** Labu syncline. **S5.** Tangga syncline. *Simple line with arrows*: Approximate boundary of synclinal basins within Brunei. **PS.** Peat body or peatswamp vegetation over low-lying ground. Map prepared by Alsa Moo & K.M. Wong, based on information from Liechti (1960), Wilford (1960) and Tate (2002).

In this series, we document new botanical findings in Brunei advanced through our research or that of our collaborators: the new taxa discovered or diagnosed, the new records of plants not previously documented in Brunei, and new and noteworthy observations. It is our hope, given the indications from past and ongoing studies, that the Brunei area continues to yield new and interesting plant taxa, and that such a series will help focus due attention on Brunei's floristic richness. As the present paper shows, both newer (post *Checklist*, Coode et al., 1996) as well as older (Ashton) collections from Brunei are still important for our continuing studies, attesting to the value of a good botanical archive in helping to attain further or newer biodiversity

documentation. All this is permitted only by sustained botanical effort and resources over the longer time frame, by necessity trans-generational in scope.

A new species of *Jarandersonia* (Malvaceae)

Jarandersonia yahyantha K.M.Wong, Joffre, Ariffin & Y.W.Low, **sp. nov.**
This new species is most similar to *Jarandersonia parvifolia* Kosterm. in having fruits with slender spines that are tuberculate and which bear tufted-hairy indumentum, but differs in its subcordate to cordate (not cuneate to rounded) leaf bases and fruit spines of 25–35 mm (not 10–15 mm) long. – TYPE: Brunei, Belait, Sg Liang, Andulau Forest Reserve, Compartment 18, Labi Road, 10 April 2014, *Ariffin, Jangarun & Rauzaidi BRUN 24174* (holotype BRUN; isotypes A, K, KEP, L, SAN, SAR, SING). (Fig. 2)

Medium sized tree 10–25 m tall, trunk slightly fluted; ***bark*** smooth, pale grey brown. ***Leaves*** broad-elliptic, 4.5–17(–22.7) cm long, 3.5–8(–11.5) cm wide; base subcordate to cordate; apex acute to rounded to obtuse to slightly emarginate; midrib flat to slightly sunken on upper surface, prominent on lower surface, secondary veins 6–8 pairs, making angular loops near the leaf margin, the basal 1–2 pairs making a smaller angle with the midrib than other secondaries (so resembling basal veins in a 3- to 5-nerved leaf base, but not reaching a fifth of the leaf length), flat to very slightly prominent on upper side, prominent on lower side; glabrous on entire upper surface, with dense, overlapping stellate scales completely occluding the lower surface; petioles 7–15 mm long, 1.5–2 mm diameter, densely stellate lepidote. ***Inflorescences*** axillary, borne in distal leaf axils, on young leafless innovations or more proximal twig portions that have lost their leaves, paniculate, to (1.5–)4–9.5 cm long, bearing (2–)4–9 flowers; bracts ovate, acute, 2–4 mm long, 1.5–2 mm broad; flower pedicels (3–)5–9 mm long (7–11 mm long in fresh material), scaly; calyx tube c. 2.5–4 mm long and 2.5–3.5 mm diameter (3–4.5 mm long and 5–6 mm diameter in fresh material), scaly outside (scale margins subentire-erose to short-fimbriate), lobes triangular, 2.5–3.5 mm long and 2.5–3.5 mm wide at base (6–7 mm long and 3–4 mm wide at base in fresh material), scaly outside; petals 5, obovate, (5.5–)7–9 mm long and 3–6 mm wide (16–18 mm long and 8–12 mm wide in fresh material), plane to slightly incurved, creamy white; stamens many, filaments 3–7 mm long (7–15 mm long in fresh material), pale greenish yellow, anthers knobby, c. 0.3 mm long, pale yellow; ovary subglobose, 5-lobed when dried, 1–1.5 mm diameter (2–3 mm diameter in fresh material), pale greenish yellow, short-hairy. ***Infructescence*** 3.5–13 cm long. ***Fruit*** subglobose, 6–10 mm diameter, 3-locular, outside covered with slender soft spines 25–35 mm long, spines tuberculate and bearing tufted hairs; seeds 1(–2), ovoid-elipsoid, 17 mm long, 4 mm wide, dark brown, smooth.

Distribution. The new species is apparently endemic to Brunei Darussalam. Of the other species in the genus, only *Jarandersonia parvifolia*, which has a widespread distribution in Sarawak, has been recorded in Brunei (*Jaamat & Tachun FMS 39640*, KEP) in the Labi Forest Reserve.

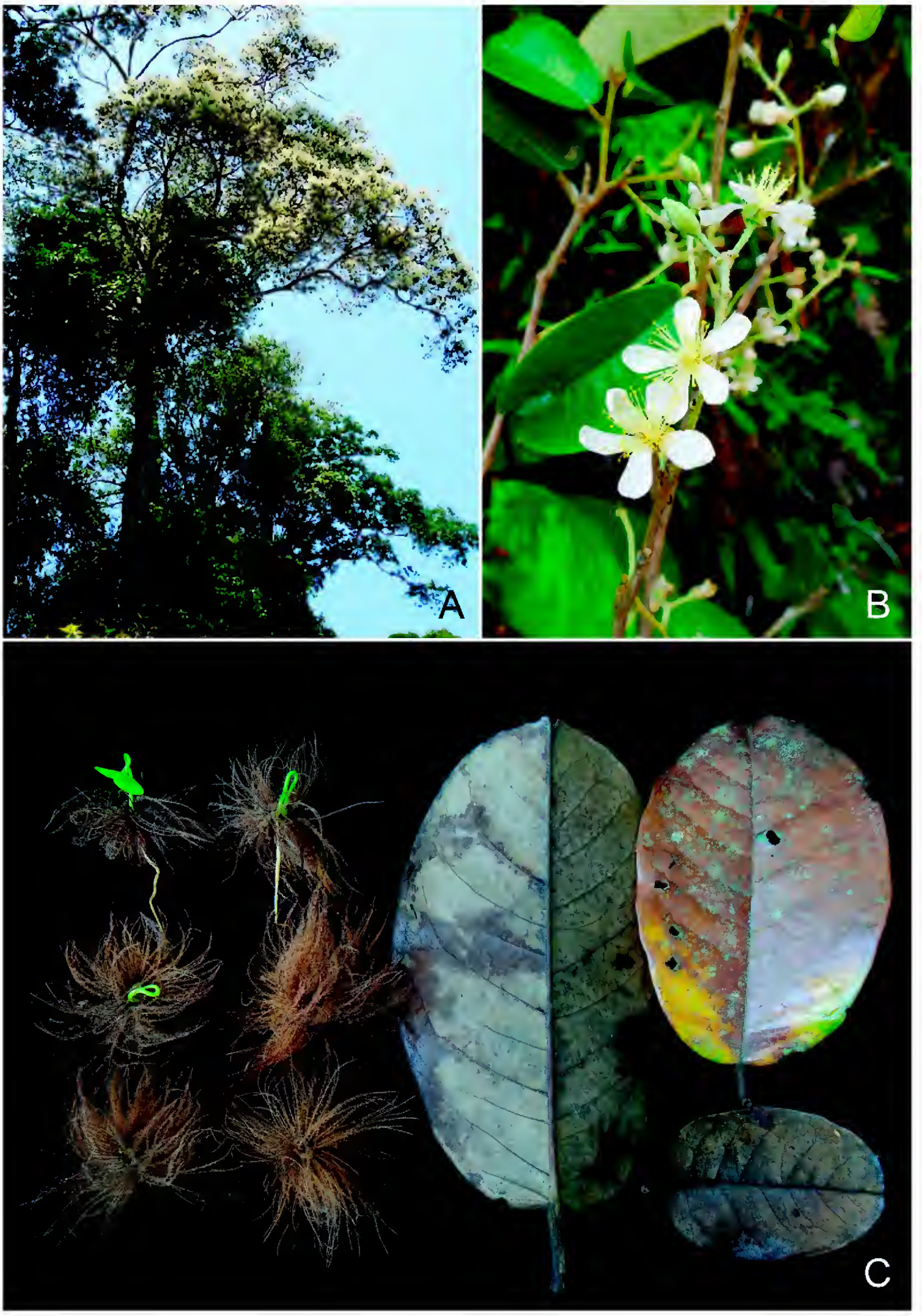

Fig. 2. *Jarandersonia yahyantha* K.M.Wong, Joffre, Ariffin & Y.W.Low. **A.** Tree in flower. **B.** Flowering branch. **C.** Fallen fruits (some germinating) and leaves. A & B from *Ariffin et al. BRUN 24087*; C from *Ariffin et al. BRUN 24174*. (Photos: A–B: Muhammad Ariffin, C: K.M. Wong)

Provisional IUCN conservation assessment. The provisional IUCN conservation status for *Jarandersonia yahyantha*, assessed with the aid of GeoCAT (Bachman et al., 2011), is Critically Endangered (CR B2ab(iii); D) (IUCN, 2012). The 'B2' designation results from an area of occupancy (AOO) estimated to be less than 10 km^2 (about 8 km2 for *J. yahyantha*); 'a' is due to a fragmented distribution as it occurs in only two populations, namely at Bukit Jerudong and Andulau Forest Reserve; 'b(iii)' is due to reductions in the area and quality of its habitat as *J. yahyantha* is so far known only in the Compartments 7 and 18 of the Andulau Forest Reserve, which has some disturbance along part of their boundary by adjacent road development, and on Bukit Jerudong near Kampung Peninjau, which is previously disturbed forest; 'D' is due to the small population size of only four mature individuals known so far.

Etymology. The new species honours Pehin Orang Kaya Seri Utama Dato Seri Setia Awang Haji Yahya bin Begawan Mudim Dato Paduka Haji Bakar, Brunei Darussalam's Minister of Industry and Primary Resources, for his interest in conservation and leadership in ceasing all timber production from Brunei's forest reserves.

Additional specimens examined. BRUNEI. **Belait:** Sungai Liang, Andulau Forest Reserve, Compartment 18, Labi Road, 200–300 m from roadside, 28 May 2014, *Ariffin, Watu & Khairul BRUN 24112* (A, BRUN, K, KEP, L, SAN, SAR, SING), *24113* (BRUN, K, SAN, SING). **Brunei-Muara:** Jerudong, Kampung Peninjau, Bukit Jerudong, 11 Mar 2014, *Ariffin, Watu, Azlan & Khairul BRUN 24087* (BRUN, K, L, SAN, SAR, SING).

Notes. There are six known species of this genus (Tan et al., 2011; Chung et al., 2012), established by Kostermans (1960), in which the fruits are typically covered with spines bearing setose hairs. Of these, the new species here is most like *Jarandersonia pentaceoides* R.C.K.Chung & H.S.Tan, *J. parvifolia* and *J. rinoreoides* Kosterm. in having slender soft fruit spines (the other species, *J. clemensiae* (Burret) Kosterm., *J. pursglovei* (Kosterm.) Kosterm. and *J. spinulosa* Kosterm., have short stout and stiff fruit spines.) The new species here differs from *Jarandersonia pentaceoides* in having short basal secondary veins that do not reach even a fifth of the length of the leaf (in that species the basal secondary veins are conspicuous in reaching halfway or more along the leaf length) and fruit spines that are 25–35 mm long (the fruit spines in that species are only 10–20 mm long). It differs from *Jarandersonia rinoreoides* in having subcordate to cordate (not typically cuneate) leaf bases and fruit spines that are 25–35 mm (not 6–28 mm) long and short-tuberculate (rather than non-tuberculate); and from *J. parvifolia* as mentioned above in the diagnosis. Leaf size is not a particularly reliable character because the flowering or fruiting material taken for herbarium specimens mostly occurs on higher branches bearing smaller leaves, although larger leaf blades may also be occasionally found on such branches.

Note that Tan et al. (2011) and Chung et al. (2012) refer to the tuberculate spines as "short-branched". Also, the regularly polygonal fine vein areoles on the lower leaf surface of *Jarandersonia pentaceoides*, which they described as "distinct honey comb-like quaternary veins", is not restricted to that species, being also found on occasion in *J. rinoreoides* (e.g., *Dewol SAN 99462* in SING); this feature is, however, absent

from the leaves of the new species described here, in which the lower leaf surface is completely occluded by dense, overlapping scales.

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Novitates Bruneienses, 2. A remarkable new species of *Begonia* sect. *Petermannia* (Begoniaceae) from Brunei Darussalam

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ABSTRACT. *Begonia jamilahana* Y.W.Low, Joffre & Ariffin is described and illustrated here as a new species based on a collection from Ladan Hills Forest Reserve, Tutong, Brunei Darussalam. This new taxon is closely related to *B. conniegeriae* S.Julia & Kiew and *B. papyraptera* Sands, but differs in a suite of morphological characters. *Begonia jamilahana* is placed in *Begonia* section *Petermannia*, the largest of all the sections recognised.

Keywords. *Begonia jamilahana*, Begoniaceae, Borneo

Introduction

Begonia is a well-known genus, largely due to its popularity in horticulture. They are mostly cultivated for their attractive foliage, as well as showy flowers (Holttum & Enoch, 1995; Tebbit, 2005). At present, there are about 1500 species distributed throughout the tropics, except in Australia, with many more taxa yet to be discovered as individual species are commonly known to be confined to very small geographical areas (Tebbit, 2005; Heywood et al., 2007; Hughes, 2008).

Merrill (1921), in his bibliographic enumeration, listed 26 species of *Begonia* for Borneo, most of which were endemic species with the exception of *B. repens* Blume. The checklist by Hughes (2008) enumerated 95 species for Borneo, all of which are strictly restricted to the island. For Brunei, Coode et al. (1996) recorded 16 species, namely, *Begonia awongii* Sands, *B. bahakensis* Sands, *B. baramensis* Merr., *B. bruneiana* Sands, *B. chlorandra* Sands, *B. cyanescens* Sands, *B. eutricha* Sands, *B. fuscisetosa* Sands, *B. hexaptera* Sands, *B. laccophora* Sands, *B. leucochlora* Sands, *B. leucotricha* Sands, *B. papyraptera* Sands, *B. sibutensis* Sands, *B. stenogyna* Sands and *B. temburongensis* Sands. Four subspecies were recognised for *Begonia bruneiana*, namely *B. bruneiana* subsp. *bruneiana*, *B. bruneiana* subsp. *angustifolia* Sands, *B. bruneiana* subsp. *labiensis* Sands and *B. bruneiana* subsp. *retakensis* Sands. All of the Brunei begonias were newly described by Sands (1996), with the exception of *Begonia baramensis* Merr.

A recent collection from the Ladan Hills Forest Reserve reveals yet another novelty for Brunei from *Begonia* section *Petermannia* (Klotzsch) A.DC. as delimited by Doorenbos et al. (1998). It has the following defining characters of the section, namely (i) 2-tepaled male flowers, (ii) anthers with unilaterally positioned slits, (iii) 5-tepaled female flowers, (iv) inflorescence protogynous, with 1–2-flowered female inflorescences, (v) trilocular ovary with axile placentation and bilamellate placentae, and (vi) fruits with equal wings. The Ladan Hills novelty is closely related to *Begonia papyraptera*, but differs in having (i) a smooth and terete stem in live material, (ii) scantily scattered translucent hispid hairs on both sides of the leaf lamina, (iii) a mature upper leaf surface that is dark green with red markings on vein axil nodes nearer to the base of the leaf, (iv) a pale green lower leaf surface, and (v) base of capsule wings cuneate. In contrast, *Begonia papyraptera* has (i) a ribbed and angular stem in live material, (ii) a leaf lamina that is glabrous on both sides, (iii) a leaf upper surface that is plain dark green with conspicuous white spots, (iv) a maroon lower leaf surface, and (v) base of capsule wings rounded. Apart from *Begonia papyraptera*, the Ladan Hills taxon is also closely related to *Begonia conniegeriae* S.Julia & Kiew, but differs in the characters enumerated in Table 1. Hence, the Ladan Hills taxon is described here as new.

New species

Begonia jamilahana Y.W.Low, Joffre & Ariffin, **sp. nov.** (sect. *Petermannia*)
Similar to *Begonia papyraptera* Sands but differs in having a smooth and terete stem, leaf blade scantily covered with translucent hispid hairs on both sides, upper mature leaf surface dark green with red markings on vein axil nodes nearer to the base of the leaf, lower leaf surface pale green, and base of capsule wings cuneate. – TYPE: Brunei, Tutong District, Lamunin, Ladan Hills Forest Reserve, Compartment 1, 58 m, 4°42'16"N 114°44'12"E, lowland mixed dipterocarp forest on yellow sandy clay soils, steep slope, 15 Dec 2010, *P. Azlan, A.K. Muhd. Ariffin, A. Watu & M. Rauzaidi BRUN 23373* (holotype BRUN (including spirit material); isotypes K, SING). (Fig. 1, 2)

Cane-like begonia, c. 40 cm tall, most parts of the plant glabrous except for the upper and lower surface of lamina scantily covered with hispid translucent hairs neatly arranged in between veins. ***Stems*** pale green, 0.8–1.5 cm thick, very succulent, terete, internodes 2.5–9 cm long, laxly branched, nodes red, not swollen. ***Stipules*** dark red, narrowly lanceolate, c. 1–2 cm long, c. 0.3–0.5 cm wide at the base, keeled, margin entire, apex acute, caducous. ***Leaves*** alternate, oblique, distant, held horizontally; petioles light green with both ends red, 5–20.5 cm long, terete; lamina dark green with red markings on vein axil nodes nearer to the base of the leaf and iridescent above, pale green beneath, young leaves very rarely with small white spots above, fading in older leaves, asymmetric, elliptic to broadly elliptic, 12–19 × 11.5–14 cm, broad side 8–10.5

cm wide, base cordate, basal lobes 3.5–7 cm, margin dentate, apex acuminate, acumen 1.5–2 cm long; venation palmate-pinnate, 7–9 veins, each branching dichotomously 2–3 times, vein nodes red near junction of petiole and gradually fading to pale green towards the margin, flat and prominent on the upper surface, raised and prominent on the lower surface. ***Inflorescences*** terminal, protogynous; *female inflorescences* (1–)2-flowered, positioned one node below the male inflorescences or solitary, peduncles absent; *male inflorescences* composed up to 4 cymose partial inflorescences, each monochasium with 3–6 flowers, peduncles 7–15 mm long. ***Bracts*** dark red, ovate, keeled, c. 0.9–1.1 cm long, c. 0.8 cm wide, margin entire, persistent. ***Male flowers***: pedicel white to pale pink, 7–9 mm long; tepals 2, pale pink with red flushes, ovate-elliptic, 7–9 × 4–5 mm, margin entire, apex rounded; stamens c. 39, cluster conical, stalked; filaments c. 0.8 mm long; anthers yellow, oblong, c. 1 mm long, apex slightly emarginate. ***Female flowers***: pedicel pale green, 4–6 mm long; ovary pale green, 1.3–2 × 0.3–0.4 cm, wings 3, equal, locules 3, placentae 2 per locule, placentation axile; tepals 5, pink, outer 4 tepals ovate, c. 18–20 × 8–11 mm, innermost tepal oblanceolate, c. 10 × 8 mm, margin entire, apex rounded; styles 3, deeply Y-shaped, c. 6 mm long, divided c. 2 mm from the base; stigma yellow, papillose forming a continuous twisted band. ***Capsules*** (1–)2, pendent, 2.7–30 × 1.5–1.7 cm, pale green when young, brown when mature, locules 3, wings 3, equal, leathery when fresh, thinly fibrous when dry, slightly expanded, tip rounded, dehiscing between locule and wing; pedicel c. 4–6 mm long.

Additional specimens examined. BORNEO: **Brunei:** Tutong District, Lamunin, Ladan Hills Forest Reserve, Ladan Hill, 20 Nov 2014, *A.A. Joffre et al. BRUN 24029* (BRUN, SING).

Distribution and habitat. *Begonia jamilahana* is so far known only from the Ladan Hills Forest Reserve, where it was documented on steep earth banks and adjacent slopes in the mixed dipterocarp forest on yellow sandy clay soils.

Etymology. This species is named for Hajah Jamilah binti Haji Abdul Jalil, acting Deputy Director of the Brunei Forestry Department, upon her retirement in 2015, as a token of appreciation for her excellent service rendered to the Forestry Department, as well as her unwavering support for the Brunei-Singapore botanical exploration programme.

Provisional IUCN conservation assessment. *Begonia jamilahana* is so far known only from a single population at Compartment 1, Ladan Hills Forest Reserve. The IUCN status proposed here is Least Concern (LC) as the species is protected in a forest reserve with no discernible threats. The Brunei Ministry of Industry and Primary Resources officially announced in 2014 that logging will be phased out in all forest reserves (Brunei Times, 2014).

Notes. *Begonia papyraptera* Sands was described in Coode et al. (1996), based on a single collection from the helipad Landing Point (LP) 286, Batu Apoi Forest Reserve,

Table 1. Comparison of morphological characteristics, habitat and distribution among *Begonia conniegeriae* S.Julia & Kiew, *B. jamilahana* Y.W.Low, Joffre & Ariffin and *B. papyraptera* Sands.

	Begonia conniegeriae	***Begonia jamilahana***	***Begonia papyraptera***
Stem (in life), texture	Smooth and terete	Smooth and terete	Ribbed and angular
Stem (in life), colour	Reddish or red brown	Pale green with red nodes	Pale green
Stem nodes (in life), swollen	Yes	No	Yes
Upper lamina surface, pubescence	Sparsely covered with translucent erect hairs	Scantily covered with translucent erect hairs	Glabrous
Upper lamina surface (in life), colour and markings	Dark green	Dark green with red markings on vein axil nodes near the leaf base	Dark green with white spots
Lower leaf surface, pubescence	Sparsely covered with translucent erect hairs	Scantily covered with translucent erect hairs	Glabrous
Lower leaf surface (in life), colour	Pale green	Pale green	Maroon
Capsule wings, shape proportion	Unequal	Equal	Equal
Capsule wing base, shape	Cuneate	Cuneate	Rounded
Habitat, substrate	Limestone	Yellow sandy clay soils	Unknown
Distribution	Lobang Cina, Gunung Mulu National Park, Marudi District, Sarawak, Malaysia	Ladan Hills Forest Reserve, Tutong district, Brunei Darussalam	Batu Apoi Forest Reserve, Temburong district, Brunei Darussalam

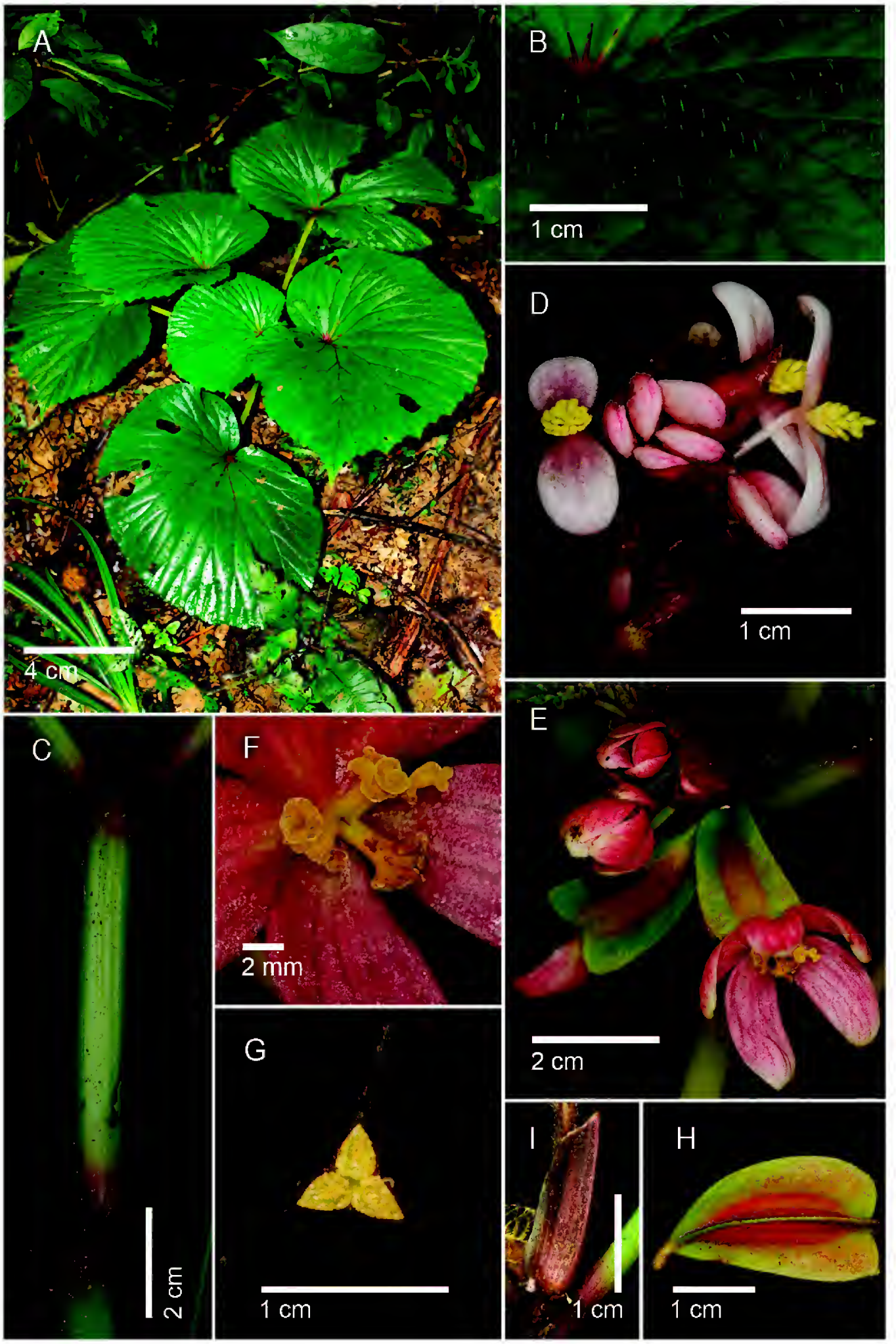

Fig. 1. *Begonia jamilahana* Y.W.Low, Joffre & Ariffin. **A.** Habit. **B.** Close-up of upper leaf surface. **C.** Detail of stem showing red nodes. **D.** Close-up of male portion of inflorescence. **E.** Close-up of female flowers. **F.** Detail of styles showing twisted papillose stigmas. **G.** Cross section of an immature fruit. **H.** Immature fruit (side view). **I.** Detail of a stipule. A & B from *P. Azlan et al. BRUN 23373*, C–J from *ex-situ* collection at BRUN. (Photos: A & B, A.K. Muhammad Ariffin; C–J, Y.W. Low)

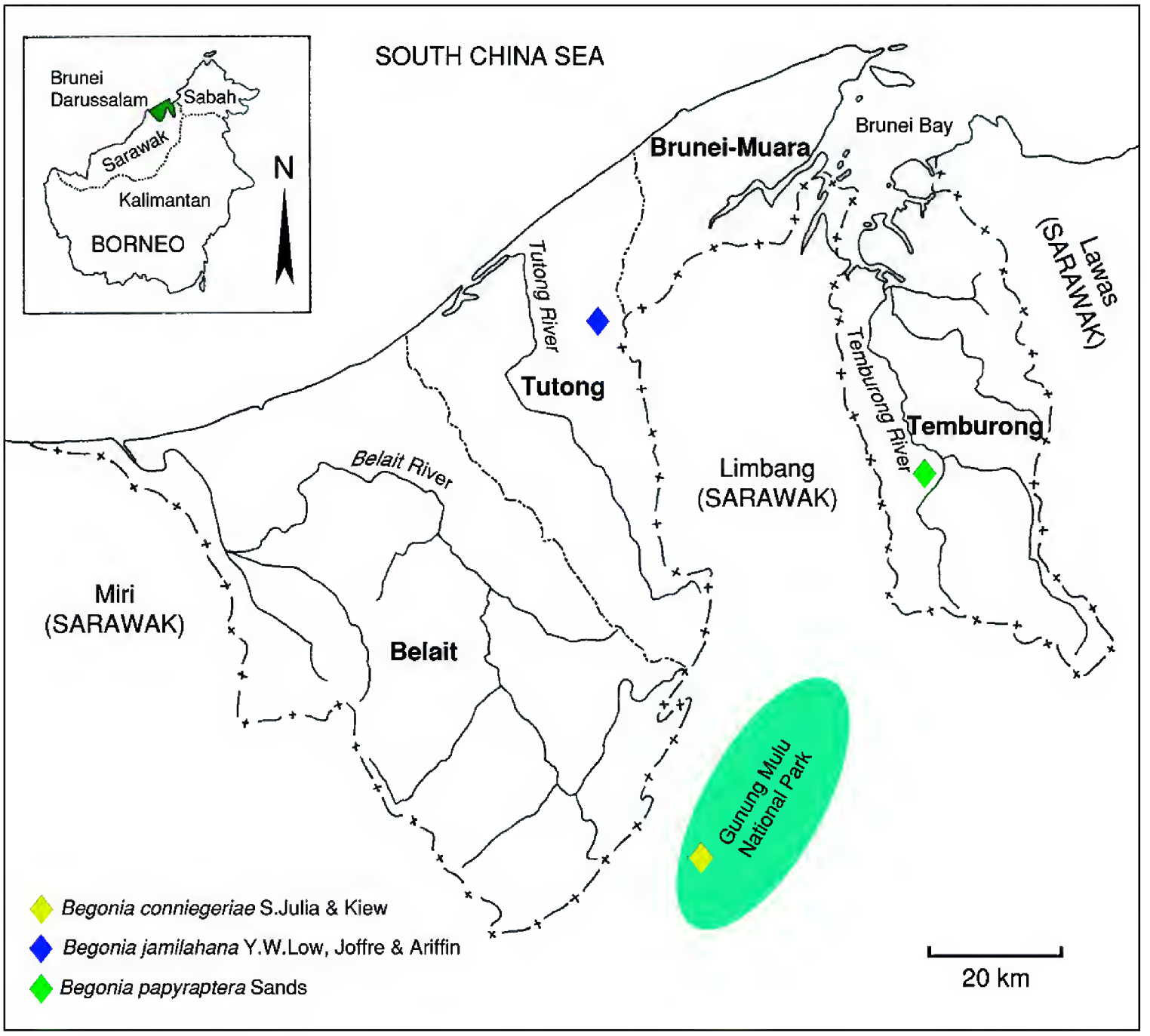

Fig. 2. Distribution of *Begonia conniegeriae* S.Julia & Kiew, *Begonia jamilahana* Y.W.Low, Joffre & Ariffin, and *Begonia papyraptera* Sands.

Temburong district (*Johns et al. RJ7422*), without a detailed description but with a brief Latin diagnosis as follows:

> "a *B. congesta* Ridley alis fructus latioribus, caulibus plusminusve glabris (non 'hirtis'), staminibus 15 vel plus (non 12), tepalis staminibus multo longioribus (non brevioribus); a *B. leucochlora* (vide supra) fructus apice rotundato (non alis acutis et fructus apice truncato), petiolis longioribus differt."

A total of three duplicates were gathered, with two sheets indicated as holotype in K (Sheet 1 of 2: K000761105, and Sheet 2 of 2: K000761106); while the third sheet, which is an isotype, is lodged in BRUN (herbaria acronyms follow Thiers, continuously updated). For this study, the two holotype sheets were examined through the Southeast

Asian Begonia database (Hughes & Pullan, 2007), as well as the JSTOR® Global Plants website (Global Plants, continuously updated). Detailed examination was carried out on the isotype preserved in BRUN. In addition, a living plant of *Begonia papyraptera* was discovered recently by the second author in cultivation in the *ex-situ* collection of begonias at the Kuala Belalong Field Study Centre (KBFSC). This cultivated specimen in KBFSC matches the type materials represented in K and BRUN and, therefore, provided us with further insights into the species for this study.

Begonia conniegeriae S.Julia & Kiew was described in Sang et al. (2013). We have been unable to examine the materials as the isotype indicated in the article as having been distributed to SING had not arrived by 13 March 2015 (Serena Lee (SING), pers. comm.). Images of the type materials were also not available for examination either in the Southeast Asian Begonia database (Hughes & Pullan, 2007) or the JSTOR® Global Plants website (Global Plants, continuously updated). The morphological characters of *Begonia conniegeriae* used in this study are extracted from Sang et al. (2013).

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Sang, J., Kiew, R. & Geri, C. (2013). Revision of *Begonia* (Begoniaceae) from the Melinau limestone in Gunung Mulu National Park and Gunung Buda National Park, Sarawak, Borneo, including thirteen new species. *Phytotaxa* 99(1): 1–34.

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Novitates Bruneienses, 3. Eight new woody plants in the Brunei flora, including five new species

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ABSTRACT. Five new species of seed plants are described: *Alangium kayuniga* K.M.Wong (Cornaceae), *Melastoma ariffinii* K.M.Wong, *Melastoma ashtonii* K.M.Wong, *Melastoma joffrei* K.M.Wong & Y.W.Low (Melastomataceae), and *Lasianthus jangarunii* Y.W.Low (Rubiaceae). New plant records for the ongoing Brunei floristic inventory include *Planchonea valida* (Blume) Blume (Lecythidaceae), *Melastoma velutinosum* Ridl. (Melastomataceae), and *Gardenia costulata* Ridl. (Rubiaceae).

Keywords. Borneo, Cornaceae, Lecythidaceae, Malesia, Melastomataceae, new records, new species, Rubiaceae, Southeast Asia

Introduction

In this third installment of the series *Novitates Bruneienses*, we report our findings of new species in four plant families. These include a new *Alangium* species (Cornaceae), three new species and a new record in *Melastoma* (Melastomataceae), a new *Lasianthus* species and a new *Gardenia* record (Rubiaceae), and a new record of *Planchonea* (Lecythidaceae). Herbarium acronyms used follow Thiers (continuously updated). All conservation assessments follow the methodology of IUCN (2012). For the new species the assessments are global, for the new records we provide national assessments for Brunei. All specimens cited have been seen by the authors.

Five new species

CORNACEAE

Alangium kayuniga K.M.Wong, **sp. nov.**
This new species is distinctive among the tree species of *Alangium* with a pinnately veined leaf base, differing from *A. havilandii* Bloemb. in its subtruncate calyx tube (the calyx tube in *A. havilandii* has distinct triangular teeth) and from *A. javanicum* (Blume) Wangerin in its thicker leaves that dry medium brown, sparse and reticulate tertiary venation and conspicuously asymmetric leaf base (*A. javanicum* has thinner leaves typically drying olive brown to purple brown, regularly conspicuous scalariform tertiary venation and typically symmetric leaf base). The new species also differs by its

glabrous calyx and fruit from both *Alangium havilandii* and *A. javanicum*, which have a velvety hairy calyx and fruit. – TYPE: Brunei, Belait, Sungai Liang, Andulau Forest Reserve, trail entrance to Compartment 7, mixed dipterocarp forest, 21 March 2007, *Yusop BRUN 22161* (holotype BRUN; isotype SING). (Fig. 1)

Small tree 10–12 m tall, trunk 8 cm diameter. ***Leaves*** elliptic, 6.5–17 cm long, 2.7–6.6 cm wide, base cuneate, asymmetric, apex cuspidate (cusp 5–12 mm long), coriaceous, glabrous, drying medium brown; midrib sunken on upper surface, prominent on lower surface, secondary veins 7–9 pairs, tertiary venation sparse and reticulate; petioles 4–7 mm long, 1–1.5 mm diameter, slightly channelled on upper side. ***Flowers*** not known. ***Infructescence*** a short cyme, peduncle 3–6 mm long, with 1–3(–4) fruits. ***Fruits*** on short pedicels 4–5 mm long, 1–1.5 mm diameter; ovoid-ellipsoid, slightly compressed with 10 longitudinal ridges and grooves, 1.8–2.2 cm long, 1.2–1.4 cm wide; glabrous, crowned by the persistent calyx limb and disc; calyx tube subtruncate, 1.5–2 mm high, glabrous. ***Seeds*** one per fruit, ellipsoid-compressed, 1.2–1.3 cm long, 0.8–0.9 cm wide, 2–3 mm thick, testa smooth.

Etymology. 'Kayu' refers to tree or wood in Brunei Malay; this species is named for Mohd. Niga bin Abdullah Nangkat, formerly Senior Forestry Assistant with the Brunei National Herbarium and now retired, who led many collecting trips in Brunei forests.

Distribution. This would seem to be a very rare and narrow endemic in Brunei as it is only known from the type collection.

Provisional IUCN conservation assessment. Data Deficient (DD) as it has only been collected once and no information is available on its distribution or population size. Further field observations would enable a better understanding of its conservation status in Brunei.

Additional specimens examined. The species is only known from the type.

Notes. The slightly compressed ovoid-ellipsoid fruit, with longitudinal ridges and grooves and crowned by the persistent calyx limb and disc, is characteristic of *Alangium* (Bloembergen, 1935, 1939). The most recent revision of Bornean *Alangium* was by Berhaman (1995), in which ten species were recognised for the island. Of these, two are climbers and another six have 3–5-veined leaf bases, characters not found in our new species. Instead, it more closely resembles *Alangium havilandii* (with asymmetric leaf bases and a swamp habitat) and *A. javanicum* (with symmetric leaf bases and a mixed dipterocarp forest provenance). However, the glabrous calyx and fruit surface of *Alangium kayuniga* is consistent for both younger and more mature fruit, whereas in *A. havilandii* and *A. javanica* the velvety nature of the calyx and fruit surface is evident from young stages and persistent through to mature fruit.

Fig. 1. *Alangium kayuniga* K.M.Wong, fruiting branch. (Photo: Muhammad Ariffin)

MELASTOMATACEAE

Melastoma ariffinii K.M.Wong, **sp.nov.**
This new species resembles *Melastoma stenophyllum* Merr. in having linear leaves and broad-triangular hypanthium scales that are less than three times as long as their width, but differs in its hypanthium scales that are subulate and basally inflated with subentire to sparsely denticulate margin, and which are more sparsely set and intermixed with minute similar scales (in contrast to the irregularly short-fringed flat hypanthium scales that are of one general size and closely overlapping in *M. stenophyllum*). – TYPE: Tutong, Ramba, Ulu Tutong, down valley to SW of helicopter pad LP 239, 4°25′N 114°50′E, 150–200 m asl, 8 May 1992, *Johns, Niga, Shanang & Han 7547* (holotype BRUN; isotype K). (Fig. 2A–B)

Melastoma polyanthum var. *linearifolium* Bakh.f., Meded. Bot. Mus. Herb. Rijks Univ. Utrecht 91: 69 (1943). – TYPE: Borneo, Gunong Narik, Kelam, May 1894, *Molengraaff B3460* (lectotype L, designated here).

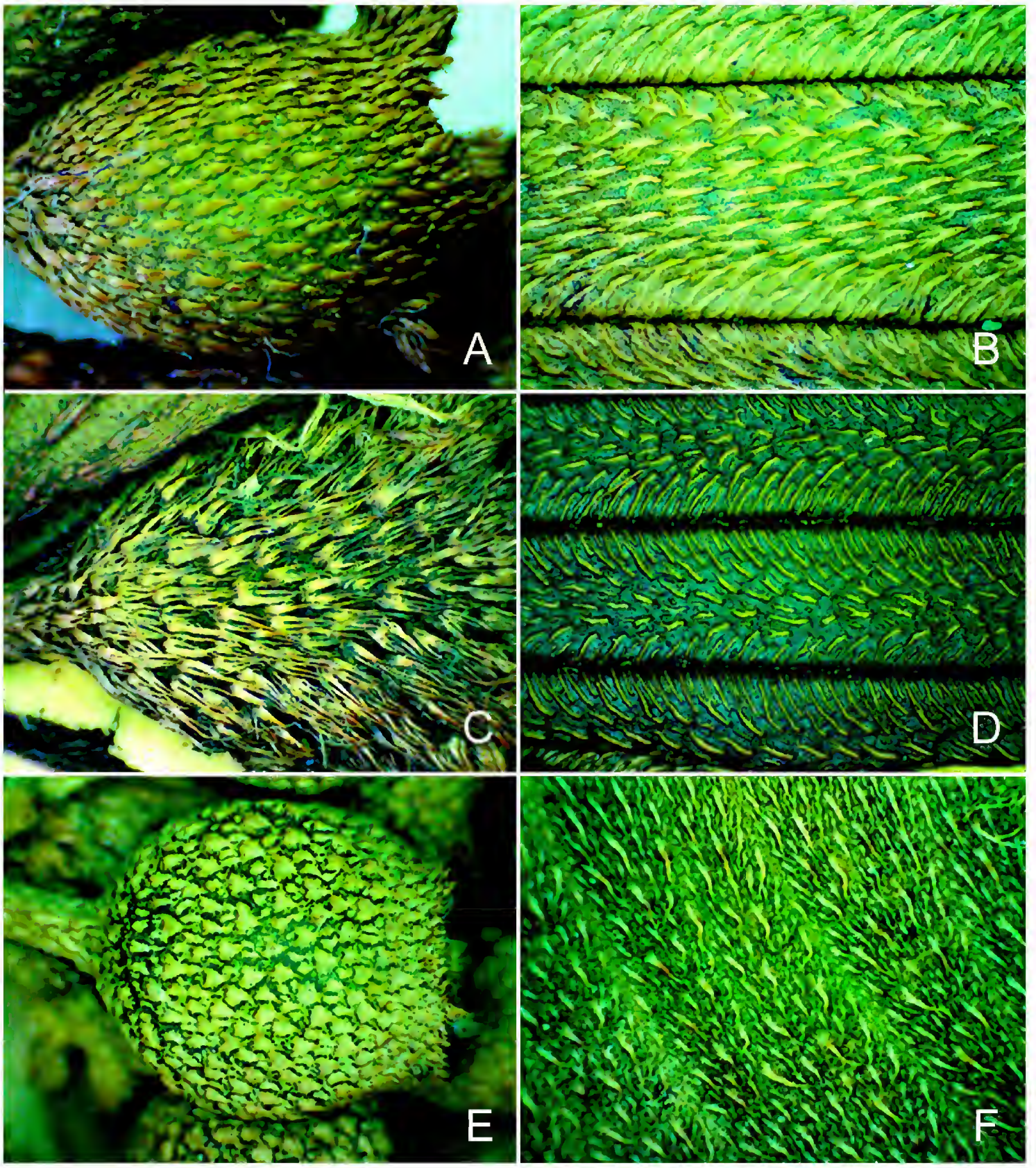

Fig. 2. Hypanthium scale types and detailed view of upper leaf surfaces in *Melastoma ariffinii* (A, B), *M. ashtonii* (C, D) and *M. joffrei* (E, F). A & B from *Othman et al. S 56078*; C & D from *Ashton BRUN 5629*; E & F from *Wong & Joffre WKM 3207* (all SING). (Photomicrographs: Y.W. Low)

Rheophytic bush 1–1.5 m high or more. ***Branch internodes*** covered with dense, appressed, ovate-lanceolate, subentire to slightly short-serrate scales. ***Leaves*** with petioles 0.4–2 cm long, c. 0.1 cm diameter; blades linear, 3.2–10 cm long, 0.4–1.5 cm wide, the 3 longitudinal veins sunken on the upper surface and prominent on the lower surface, covered by a mixture of larger lanceolate appressed scales (c. 1 mm long) and smaller appressed lanceolate scales (<0.3 mm long), lamina on the upper surface

in dried material with abundant conspicuous elongate spicule-like patterns formed by rows of pale crystalliferous cells, glabrous or occasionally with micro-hairs less than 0.1 mm long (Fig. 2B), on the lower surface with scabrid scales with emergent scabrid tips to 0.1 mm long. ***Flowers*** 1–3 in short cymes, peduncle 3–5 mm long, branches 1–2 mm long only; pedicels 4–6 mm long; hypanthium (Fig. 2A) 5–7 mm long, 4–6 mm diameter, green then magenta, with sparsely arranged scales, the scales subulate and basally inflated, to 2 mm long, with entire to sparsely denticulate margins, intermixed with minute similar scales mostly 0.5–1 mm long or shorter, lobes 5, broad-triangular, 5–6 mm long, alternating with inter-sepalar protuberances 1–2 mm long; petals obovate, c. 2.5 cm long, 1.8 cm broad, mauve; stamens not seen. ***Fruits*** c. 9 mm long, 8 mm diameter, green to reddish brown.

Etymology. The species is named after Muhammad Ariffin A. Kalat, experienced forest botanist at the Brunei National Herbarium.

Distribution. This is apparently the common rheophytic *Melastoma* species in clearwater streams of the Northwest Borneo region, including Brunei, Sarawak and W Kalimantan.

Provisional IUCN conservation assessment. Least Concern (LC) as the species is common and widespread. Besides that, the habitat in Brunei is also protected in Forest Reserves and a National Park.

Additional specimens examined. BRUNEI: **Temburong:** First big waterfall on R. Temburong, c. 500 ft, 6 Nov 1959, *Ashton BRUN 759*, (BRUN, K, SING). MALAYSIA: **Sarawak:** 5th Division, Ulu Lawas, Kota Forest Reserve, on bank of Sg. Kota, 21 Oct 1971, *Chai & Ilias S 31110* (A, K, L, SAN, SAR, SING); Kapit Division, Balleh, Ulu Mengiong, Sg. Entejum, 27 Oct 1988, *Othman, Rantai & Jugah S 56078*, (K, KEP, L, SAR, SING); Kapit Division, Sg. Belaga at upper rapids, 12 Apr 1963, *Ashton S 18242* (K, L, SAR, SING).

Notes. Meyer (2001) had apparently not studied specimens of this rheophytic *Melastoma* taxon in Borneo; none bears his annotation or are mentioned or indexed in his revision. He placed *Melastoma polyanthum* var. *linearifolium* Bakh.f. in the synonymy of *M. malabathricum*, but the variety has not hitherto been lectotypified. The syntypes are *Molengraaff B3460* from Mount Kelam in W Kalimantan (L) (which is our *M. ariffinii* here) and *Seimund* s.n. from Kwala Teku in the Malay Peninsula (K: K000867833) (which is a narrow-leafed rheophytic form of *M. malabathricum*). Ridley's *Melastoma polyanthum* var. *angustifolium* (Ridley 1922: 765, as *'angustifolia'*) was applied to this Malay Peninsula taxon and requires lectotypification (to be addressed in a separate review of the Malayan species), but in any case is different from our new species here. Here we lectotypify *Melastoma polyanthum* var. *linearifolium* with the Bornean specimen, as Bakhuizen's work addressed mainly the Netherlands East Indies (Bakhuizen van den Brink Jr., 1943).

The Sumatran rheophyte *Melastoma stenophyllum* was also reduced by Meyer (2001) to synonymy under *M. malabathricum* L. although it is, in our view, quite

distinct: not only because the leaves are stenophyllous in an extreme manner, with blade lengths 9–11 times the width (much more linear than narrow variations of the typically elliptic leaves in *M. malabathricum* which has blade lengths 5–7(–8) times the width), but also the flowers are typically solitary (compared to cymes of several to 7–9 flowers in *M. malabathricum*).

Steenis (1981) confused *Melastoma ariffinii* with *M. borneense* (Cogn.) Bakh.f., which is typified by a collection from West Kalimantan: *De Vriese 168* (L). The *De Vriese* collection has leaves just 1.3–2.2 cm wide, but still clearly elliptic in shape, and not sufficiently linear as in the truly rheophytic taxa; *Melastoma ariffinii* here has leaves that are linear and only 0.4–1.5 cm wide (length 8–10 times the width). Also, the *De Vriese* specimen has 2–7 flowers in a cyme, and a hypanthium with short-fringed, flat ovate-triangular scales, whereas *Melastoma ariffinii* has only 1–3 flowers and hypanthium scales that are subentire to remotely denticulate, and subulate inflated structures. Lastly, the upper leaf surface has scabrid hairs 0.3–0.5 mm long in *Melastoma borneense* but subglabrous with only occasionally scabrous micro-hairs less than 0.1 mm long in *M. ariffinii*, so that the latter's upper leaf surface is not scabrid to the touch. We agree with Meyer (2001) that *Melastoma borneense* is synonymous with *M. malabathricum*; the two taxa have the same hypanthium scales and leaf upper surface characters, among others.

Melastoma ashtonii K.M.Wong, **sp.nov.**

This new species resembles *Melastoma stenophyllum* Merr. in having linear leaves, but differs in its hypanthium scales that are basally thickened and deeply incised into linear segments (Fig. 2C) (in contrast to the fringed flat ovate-triangular scales on the hypanthium in *M. stenophyllum*). – TYPE: Brunei, Belait, Sg. Ingei, rocky river bank, 21 January 1959, *Ashton BRUN 5629* (holotype BRUN; isotypes K, L, SAR, SING). (Fig. 2C–D)

Rheophytic bush 1–2 m high, stems sometimes gnarled. ***Branch internodes*** covered with dense, appressed, ovate-lanceolate, subentire to slightly short-serrate scales. ***Leaves*** with petioles 0.5–1.4 cm long, c. 0.1 cm diameter; blades linear, 3.5–9 cm long, 0.4–1 cm wide, the 3 longitudinal veins sunken on the upper surface and prominent on the lower surface, covered by a mixture of larger lanceolate scales 0.5–1.2 mm long and smaller lanceolate scales 0.2–0.3 mm long, lamina on the upper surface in dried material with abundant conspicuous pale elongate rows of crystalliferous cells forming spicule-like patterns and quite glabrous (Fig. 2D), on the lower surface with scabrid scales with 0.2–0.3 mm emergent scabrid tips. ***Flowers*** 1–3 in short sessile cymes, branches 1–2 mm long only; pedicels 1–4 mm long; hypanthium 10–11 mm long, 7–8 mm diameter, green then crimson, moderately to densely scaly, the scales with an entire thickened base 0.1–0.2 mm high and linear segments 0.6–1.4(–2) mm long, lobes 5, narrowly triangular, 8–10 mm long, alternating with inter-sepalar lobes 4–5 mm long; petals obovate, c. 3.3 cm long, c. 2 cm wide, mauve; short stamens with a filament c. 7–8 mm long and anthers c. 5 mm long and 2.5–3 mm wide, with

apiculate tips, long anthers only one seen, filament unknown, anther c. 12 mm long. ***Fruits*** (young) c. 8 mm long, 4 mm diameter, green to reddish brown.

Etymology. The species is named after Professor Peter Shaw Ashton, Brunei's first Forest Botanist who collected the type on his first assignment to the tropics, and who later taught at Aberdeen and Harvard Universities.

Distribution. Known only from the Sungai Ingei area in Brunei.

Provisional IUCN conservation assessment. Least Concern (LC) as the habitat of the species is well protected in the Sungai Ingei Conservation Area, which is also now included within the designated Heart of Borneo area within Brunei.

Additional specimens examined. BRUNEI: **Belait:** Falls just upstream from Batu Melintang, 4 Jan 1989, *Wong WKM 680* (BRUN, K, SING).

Notes. See comments under *Melastoma ariffinii* above. The new rheophytic species here, *Melastoma ashtonii*, is also clearly different from *M. malabathricum* by its hypanthium scale type: basally thickened scales that are deeply incised into linear segments, often resembling miniature rakes, instead of the irregularly short-serrate to shallowly laciniate flat narrowly triangular-lanceolate scales as in *M. malabathricum* (Fig. 3). Also, in both *Melastoma malabathricum* and *M. stenophyllum*, the pale spicule-like patterns formed by rows of crystalliferous cells embedded in the upper leaf surface are distally continuous with short scabrid hairs, but the upper laminar surface in *M. ashtonii* is quite glabrous. In addition, *Melastoma ashtonii* has rather conspicuous inter-sepalar lobes 4–5 mm long, compared to the much less conspicuous ones that occasionally occur in *M. malabathricum*, absent altogether in *M. stenophyllum*.

Steenis (1981: 283) had already noticed the potential novelty of this taxon, which he enumerated as "Melastoma *sp.* (*nov.?*)" in his *Rheophytes of the World*.

Melastoma joffrei K.M.Wong & Y.W.Low, **sp.nov.**
This species is unique among *Melastoma* species with isomorphic stamens by its hypanthium covered by small triangular scales of different sizes (Fig. 2E) (not hairlike bristles as in *M. cynoides* Sm. and *M. moluccanum* Blume, nor penicillate emergences as in *M. montanum* (Lauterb.) K.Meyer), very small bracts that do not enclose the hypanthium (unlike in *M. montanum*), and scabrid upper leaf surfaces with a mixture of longer and tiny coarse suberect to upcurved hairs (Fig. 2F) (not strigose to appressed pilose upper leaf surfaces as in the other species). – TYPE: Brunei, Tutong district, Rambai, Ladan Hills Forest Reserve, on ridge NE of campsite beside Sungai Buing, along old logging track, 13 October 2012, *Wong & Joffre WKM 3207* (holotype BRUN; isotype SING). (Fig. 2E–F, 4)

Treelet (single-stemmed) or shrub (with several stems from the base) to 1.5 m high. ***Branch internodes*** coarse with dense, spreading to erect small triangular scales.

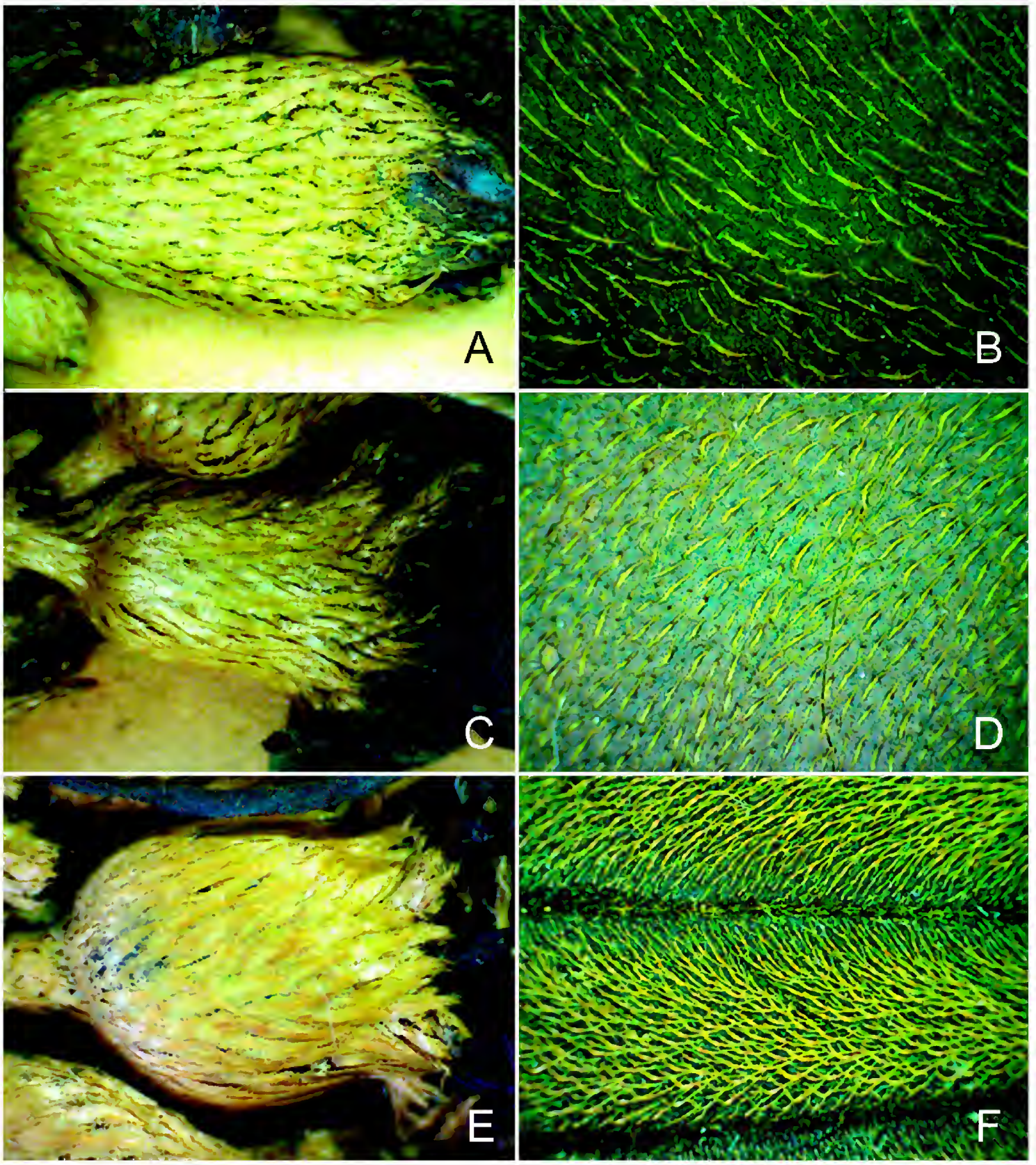

Fig. 3. Consistently narrowly lanceolate, serrate-laciniate and densely overlapping hypanthium scales, and scabrid-hairy upper leaf surfaces in *Melastoma malabathricum* from the Malay Peninsula (A, B), Sabah (C, D) and Sarawak (E, F). A & B from *Jagoe s.n.*; C & D from *Kadir A 2855*; E & F from *Moulton 6723* (all SING). (Photomicrographs: Y.W. Low)

Leaves with petioles 0.6–2 cm long, with a mixture of scattered to dense suberect short scales and scabrid hairs; blades ovate-elliptic, 5.5–12.5 cm long, 1.5–4.5 cm wide, longitudinal nerves 3–5(–7), sunken on upper surface, raised on lower surface and bearing a mixture of suberect short scales and scabrid hairs, transverse veins between the nerves scalariform, slightly sunken on upper surface, raised on lower surface;

Fig. 4. *Melastoma joffrei* K.M.Wong & Y.W.Low. Open flowers showing isomorphic stamens. Inset: Detail of upper leaf surface showing different hair types contributing to a sandpapery roughness. All from *Wong & Joffre WKM 3207*. (Photos: K.M. Wong)

upper laminar surface with a mixture of longer and tiny coarse suberect to upcurved hairs, scabrid-sandpapery to the touch; lower laminar surface similarly scabrid. ***Inflorescence*** a compact terminal cyme of (7–)9–13 flowers, main cyme branches 3–11 mm long, bracts tiny, broad triangular to semicircular, c. 1 mm long and wide. ***Flowers*** small, only c. 2 cm across; hypanthium urceolate, 4.5–5 mm long, 4.5–5 mm wide, surface scales short triangular, appressed, margins minutely denticulate, not or only slightly imbricate and not entirely obscuring the hypanthium surface, green; calyx lobes 5, broadly triangular, 1.5–2.5 mm long, 1–2 mm wide; petals 5, obovate, 6–7.5 mm long (8–9 mm in fresh material), 4–5.5 mm wide (5–6 mm in fresh material), the apex subtruncate to rounded, margins short-ciliate, pale purple-pink; stamens 10, isomorphic, filaments 3–4 mm long (3.4–4.5 mm in fresh material), white, each apically bearing two knoblike pale yellow appendages at the insertion of the anther, anthers erect, 2–2.5 mm long (2.5–3 mm in fresh material), pale creamy yellow, apex rounded, opening by apical pores; style slender-cylindric, 4.5–5.5 mm long (5.5–7 mm in fresh material), with a pale green base, then pink for the most part, apically pale yellow; stigma rounded to subtruncate, 4–5-lobed, pale green. ***Fruit*** urceolate to subglobose, 5.5–6 mm long, 5.5–6 mm wide, dehiscing irregularly transversely.

Etymology. The species is named for our colleague Joffre bin Haji Ali Ahmad, Forest Botanist at the Brunei National Herbarium and experienced and long-time collector of Brunei plants.

Additional specimens examined. BRUNEI: **Tutong:** Rambai, Ladan Hills Forest Reserve, Sg. Buing, disturbed mixed dipterocarp forest, on ridge, 29 Oct 2013, *Ariffin, Low, Y.W. & Azlan BRUN 23229* (BRUN, SING). MALAYSIA. **Sarawak:** Tatau district, Anap, Muput Kanan, Ulu Naoung, 6 m asl, 14 Oct 1963, *Ashton S 19569* (A, BO, K, KEP, L, SAN, SAR, SING).

Distribution. Known only from the type locality in Brunei and another collection in Sarawak's Tatau district.

Provisional IUCN conservation assessment. Data Deficient (DD) as it has been only twice collected with one of the collections made over 50 years ago. Field observations are badly needed for a better understanding of its conservation status.

Notes. In Meyer's revision of *Melastoma* (Meyer, 2001), there is a small group of three *Melastoma* species with isomorphic stamens, *M. cynoides*, *M. moluccanum* and *M. montanum*, which he recognises for the more seasonal parts of insular SE Asia and New Guinea; the rest of the species in the genus have flowers with dimorphic stamens. *Melastoma joffrei* is Borneo's first known *Melastoma* species with isomorphic stamens.

RUBIACEAE

Lasianthus jangarunii Y.W.Low, **sp. nov.**
This new species resembles *Lasianthus linearifolius* H.Zhu in having linear leaves but differs by having triangular stipules, bullate leaves with a thin-papery and crispy texture, a revolute margin and brochidodromous venation (with 17–40 pairs of secondary veins forming a distinct marginal vein), and a calyx with shorter tube (c. 0.4 mm long) and shorter lobes (c. 0.4–0.9 mm long). In contrast, *Lasianthus linearifolius* has awl-shaped (subulate) stipules, leaves with a plane surface and leaf margin, subcoriaceous texture, craspedodromous venation (with 10–16 pairs of secondary veins), and a calyx with longer tube (c. 1 mm long) and longer lobes (c. 1 mm long). – TYPE: Brunei, Temburong, Amo, Sungai Temburong and Sungai Machang junction, ridge, 120–250 m alt., 18 September 1990, *Puff et al. 900818-1/11*, mature fruits (holotype BRUN; isotypes K, SAR, SING 2 sheets). (Fig. 5)

Understorey treelet c. 2 m high, stem c. 3–4 mm wide. ***Branches*** solitary, slender, terete, c. 1–2 mm wide, sparsely puberulent to subglabrous. ***Stipules*** narrowly triangular, c. 1–3 mm long, sparsely puberulent. ***Petiole*** 4–6(–7) mm long, 0.8–1.2 mm wide, sparsely puberulent. ***Leaf*** lamina linear, (8.5–)11–13.7(–18.4) cm long, (0.8–)1–1.5(–2.2) cm wide, bullate, thin-papery and crispy; leaf base cuneate; leaf apex long-caudate; leaf margin entire to slightly repand, revolute; midrib prominent

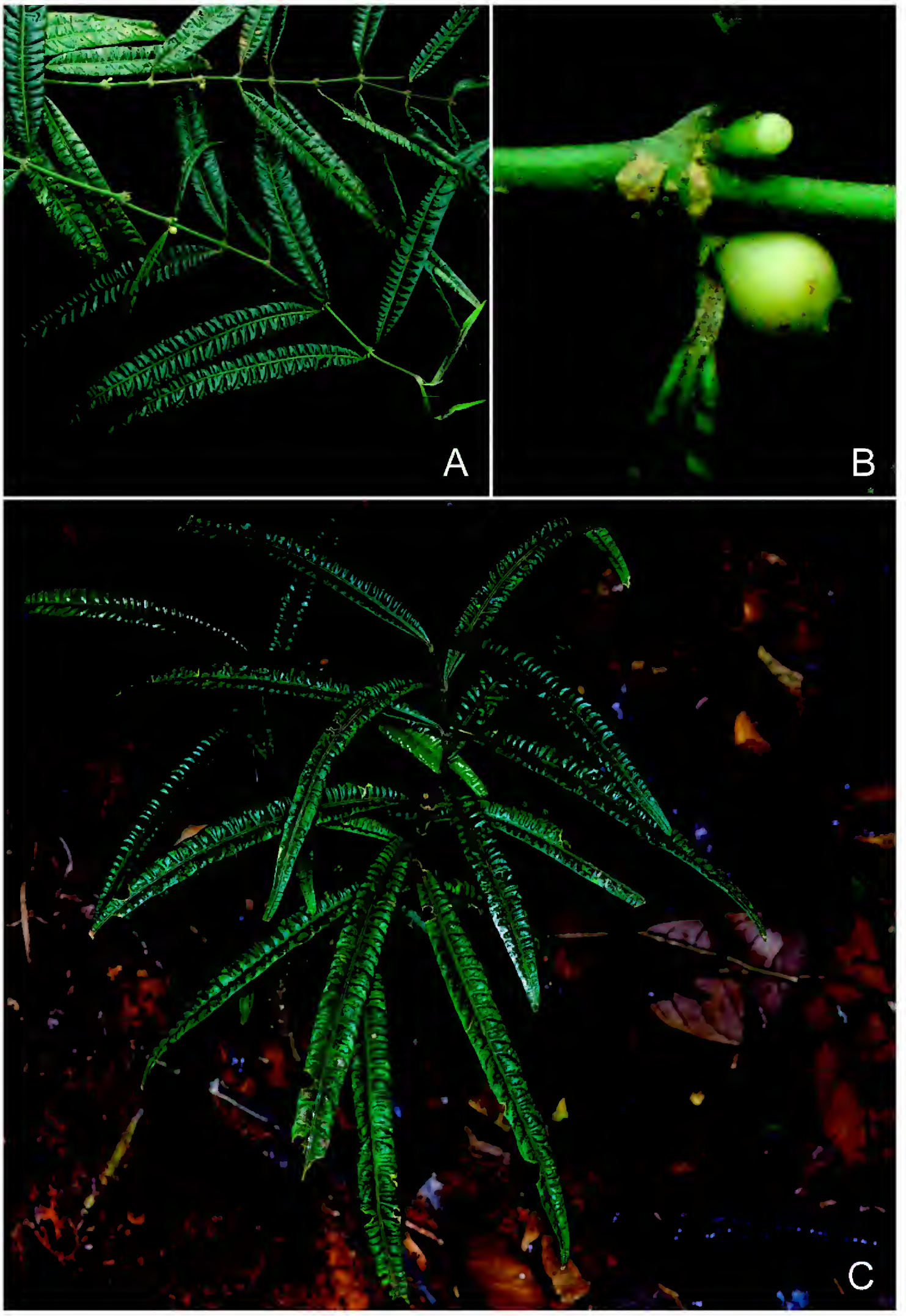

Fig. 5. *Lasianthus jangarunii* Y.W.Low. **A.** Branches with conspicuously corrugated leaves. **B.** Close-up of a flower bud and an immature fruit with persistent calyx lobes visible. **C.** Habit (Ulu Temburong National Park). All from *Low et al. LYW 629*. (Photos: A–B: K.M. Wong, C: Y.W. Low)

and glabrous on both sides; secondary veins 17–40 pairs, making an angle of 85–90° with the midrib and joining to form a distinct marginal vein, inconspicuous to slightly raised and glabrous on upper side, prominent and glabrous on lower side; tertiary venation inconspicuous to slightly raised on upper side, inconspicuous on lower side. ***Inflorescences*** sessile; bracts absent. ***Flowers*** fascicular, sessile; calyx campanulate, tube c. 0.4 mm long, outside surface puberulent; marginal lobes 4(–5), triangular, c. 0.4–0.9 mm high; corolla hypocrateriform, white; tube c. 1 mm long, outside puberulent; lobes 4(–5), triangular, c. 1.2 mm long, c. 1 mm wide, valvate, outside puberulent. ***Drupes*** subglobose, c. 2–3 mm long, 2.5–3 mm wide, 4(–5)-ridged when dry, puberulous, maturing black (*Kirkup et al. 898*); calyx persistent at fruit apex, with 4(–5) small triangular calyx lobes. Pyrenes 4(–5), thick-walled, each with a single seed.

Etymology. This species is named for Jangarun anak Eri, knowledgeable field assistant and tree climber attached to the Brunei National Herbarium (BRUN), who has assisted numerous botanists with fieldwork.

Distribution and habitat. *Lasianthus jangarunii* is endemic to northwest Borneo (Brunei: Temburong district, and Sarawak: Marudi district), where it grows on clay-rich sedimentary soils as an understorey treelet on steep slopes of mixed dipterocarp forest.

Provisional IUCN conservation assessment. Least Concern (LC) as the species is protected in the Ulu Temburong National Park in Brunei and, although only collected twice, in Sarawak it is recorded from Pulong Tau National Park where the habitat is also protected.

Additional specimens examined. BRUNEI: **Temburong:** Amo, Kuala Belalong ('Kuala Temburong' on label), hill, 21 Jul 1988, *Wong WKM 253*, leafy branch (BRUN, K, SING), Batu Apoi Forest Reserve, on slope along Sungai Engkiang, 20 Nov 1991, *Hansen 1592*, young fruits (BRUN); Amo, Ulu Belalong, LP 382, ridge top, 22 Jan 1994, *Kirkup et al. 898*, young fruits (BRUN); Amo, Ulu Temburong National Park, hill behind Lubok Umar, ridge, 18 May 2014, *Low et al. LYW 629*, flower buds (BRUN, K, L, SAN, SING). MALAYSIA. **Sarawak:** Marudi, Pulong Tau National Park (western part), Ulu Sungai Baong, on steep slope, 931 m asl, 10 May 2007, *Sang et al. S 98058*, young fruits (K, KEP, L, SAN, SAR, SING); ibidem, trail along the ridges to Bukit Tenidan, 11 May 2007, *Muliati et al. S 97911*, fruits (KEP, SAR).

Notes. Davis in Coode et al. (1996) identified this species as a taxonomically distinct entity of *Lasianthus* from Temburong, which was listed only as *Lasianthus* "sp. 7". Zhu et al. (2012) evidently overlooked Coode et al. (1996) and this species while preparing for the revision of Malesian *Lasianthus*; he stated that only "a selection of the Malesian collections in the herbaria BKF, KEP, MO, and SING" had been consulted. A recent collection from Ulu Temburong National Park (*Low et al. LYW 629*) matched *Lasianthus* "sp. 7" of Davis (Coode et al., 1996), and is distinct from all other *Lasianthus* taxa recognised by Zhu et al. (2012). This is so far the only known *Lasianthus* species in Malesia with strongly bullate and linear leaves.

Table 1. Comparison of morphological characteristics and distribution between *Lasianthus jangarunii* Y.W.Low and *L. linearifolius* H.Zhu.

Lasianthus jangarunii	***Lasianthus linearifolius***
Stipules triangular	Stipules awl-shaped (subulate)
Leaves bullate	Leaves smooth
Leaf texture thin-papery and crispy	Leaf texture subcoriaceous
Leaf margin revolute	Leaf margin plane
Secondary veins 17–30 pairs	Secondary veins 10–16 pairs
Loop-veined secondary venation (brochidodromous)	Secondary venation emerging from the midrib running towards and terminating at the leaf margin (craspedodromous)
Calyx tube c. 0.4 mm long	Calyx tube c. 1 mm long
Calyx lobes c. 0.4–0.9 mm long	Calyx lobes c. 1 mm long
Restricted to northwest Borneo (Brunei: Temburong district, and Sarawak: Marudi district) on clay-rich sedimentary soils	Restricted to Mount Kinabalu (Malaysia: Sabah) on ultramafic soil

Lasianthus jangarunii differs from *L. linearifolius*, which also has linear leaves, by its stipules, leaf texture and venation, and calyx dimensions (see diagnosis above). The character-states are compared in Table 1.

Apart from that, *Lasianthus jangarunii* is restricted to northwest Borneo (Brunei: Temburong district, and Sarawak: Marudi district) on clay-rich sedimentary soils, whereas *L. linearifolius* is endemic to Mount Kinabalu (Sabah) growing on ultramafic soil.

Lasianthus has some consistent characters that are easily recognised, when adequate material permits, such as paired axillary inflorescences and pyreniferous blue fruits (as in the type *L. cyanocarpus* Jack, but there are some species with white, red or black fruits). In addition, *Lasianthus* spp. are more typically treelets in the forest understorey with only solitary (not paired) primary branches developing along the vertical stem. This branching feature was not noted in Zhu et al. (2012) but is nevertheless important and represented in more recent collections of the genus; a good example was illustrated for *Lasianthus pedicellatus* H.Zhu in Zhu et al. (2012: 72, Fig. 30).

New plant records for Brunei

LECYTHIDACEAE

Planchonea valida (Blume) Blume

BRUNEI. **Temburong:** Amo, Kuala Belalong, Field Study Centre, 24 Apr 1998, *Joffre BRUN 19016* (BRUN).

This is a new tree genus and species record for Brunei, collected after the publication of Coode et al. (1996).

Provisional IUCN Conservation Assessment. Data Deficient (DD) for Brunei as the species is only known from a single collection from Kuala Belalong. Further field observations are needed for a better understanding of its conservation status in Brunei.

MELASTOMATACEAE

Melastoma velutinosum Ridl.

BRUNEI: **Belait:** Labi, Labi Forest Reserve, Compt 49, Ulu Sungai Rampayoh, 19 May 2009, *Yusop BRUN 22636* (BRUN); Melilas, Ulu Ingei hotsprings, 4º08'N, 114º43'E, 20 m asl, 7 Mar 1996, *Joffre BRUN 17295* (BRUN, SING). **Tutong:** Rambai, Ladan Hills Forest Reserve, Bukit Bedawan, northwest of LP 263, 4º29′33″N 114º48′52″E, 250 m asl, 28 Mar 1997, *Joffre BRUN 18147* (BRUN, SING).

This species is known for the Malay Peninsula and Borneo (Sabah and Sarawak) (Meyer, 2001). The several collections here record it for Brunei for the first time.

It is a treelet (single-stemmed) or shrub (with several stems from the base) to 3 m high. Distinctive features include the branch internodes that are hirsute with dense, spreading to curved long bristles; ovate-elliptic leaves with 3–5(–7) longitudinal nerves and an upper lamina surface that is appressed-pilose (hairs to 0.5 mm long), slightly velvety to the touch; a compact terminal cyme of 3–7 small flowers (only 2 cm across in dried material); and a hypanthium densely covered by slender bristles 3–5 mm long.

Provisional IUCN conservation assessment. Least Concern (LC) for Brunei as the species is common. This species occurs throughout northwest Borneo.

RUBIACEAE

Gardenia costulata Ridl.

BRUNEI: **Belait:** Andulau, without date, *Ashton A2865* (BRUN). **Temburong:** Bukit Patoi, without date, *Ashton 3970* (BRUN).

Gardenia costulata Ridl. was first described by Ridley (1934) based on a single collection (*Beccari 1986*, K, BM) from Sarawak. While reviewing Sundaland *Gardenia*, Low (2010) enumerated additional materials of *G. costulata*, including a collection for Sabah (*Madius SAN 50094*) and Kalimantan (*Hallier B1285*), most of which had been erroneously identified as *G. pterocalyx* Valeton in many herbaria. *Gardenia costulata* has truncate stipules with a revolute margin, and thin-coriaceous leaves with an acuminate to long-cuspidate apex and a pubescent lower leaf surface. These vegetative features adequately permit its distinction from *G. pterocalyx*, which also has truncate stipules but with a plane margin, and thicker leaves with a typically rounded apex and a glabrous lower leaf surface. Although the two Brunei specimens at the Brunei Herbarium were without flower or fruit, it was possible to match these two specimens to *G. costulata* based on the distinctive stipule character, the shape of the leaf apex, the leaf texture, and the presence of pubescence. Apart from morphological characters, the *kerangas* vegetation at Bukit Patoi in Brunei where *Ashton 3970* was collected also matches the habitat known for other specimens of *G. costulata*.

Gardenia costulata is restricted to Borneo, and so far has only been recorded from *kerangas* forest. The habitat of *Ashton A2865* from Andulau is not known, although the main habitat type recorded for Andulau is Mixed Dipterocarp Forest (Ashton, 1964).

Provisional IUCN conservation assessment. Data Deficient (DD) for Brunei as the species is only known from two localities, namely Andulau (Belait District) and Bukit Patoi (Temburong District). Field observations are badly needed for a better understanding of its conservation status in Brunei.

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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 sammannaniana* 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. darwinii* 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. darwinii* 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,

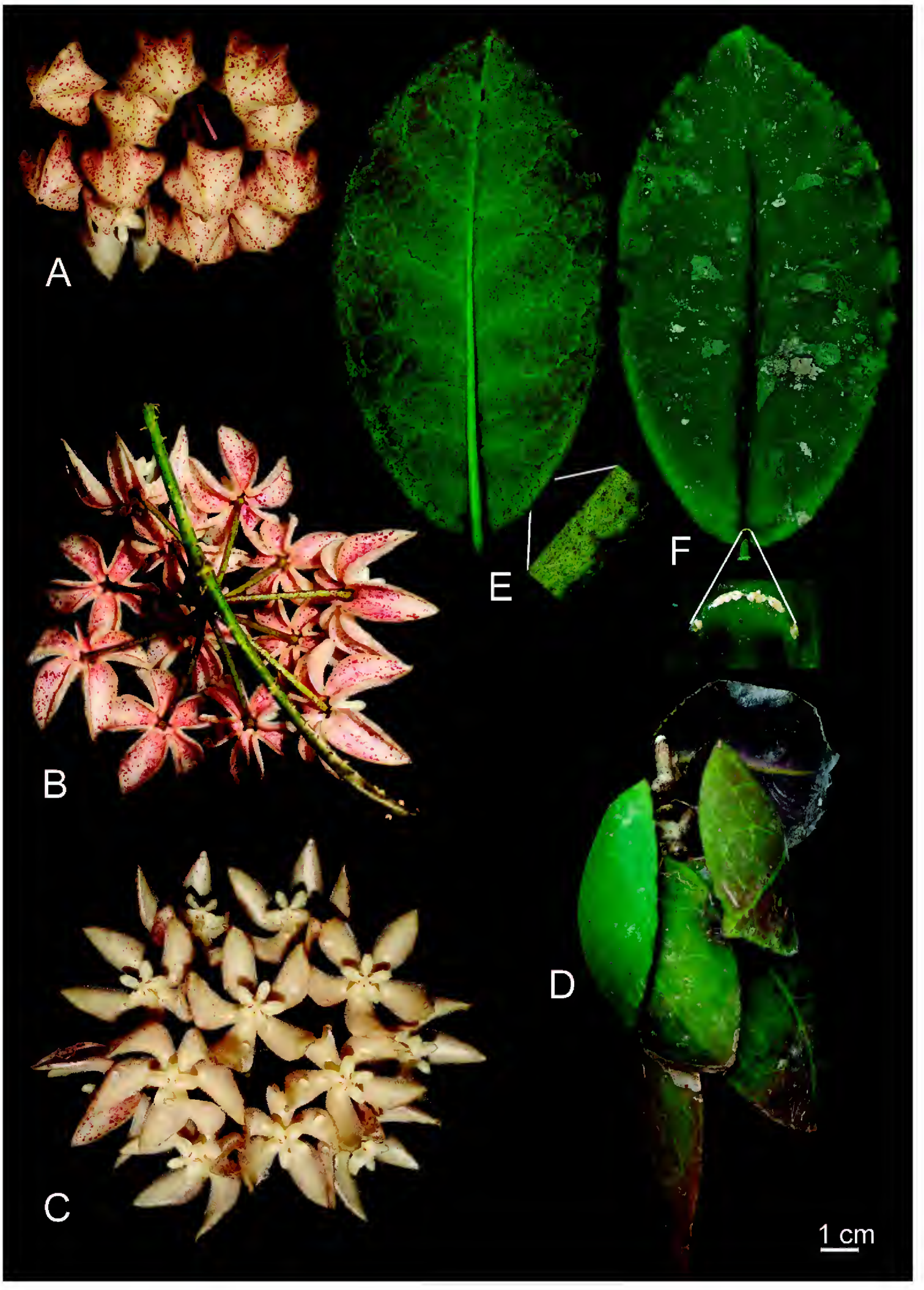

Fig. 1. *Hoya undulata* S.Rahayu & Rodda (from *M. Rodda MR650*, SING) **A.** Buds. **B.** Inflorescence, top view. **C.** Inflorescence from underneath. **D.** Domatia; **E.** Leaf, abaxial, with a magnification of the minutely undulate margin. **F.** Leaf, adaxial, with a magnification of the basal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

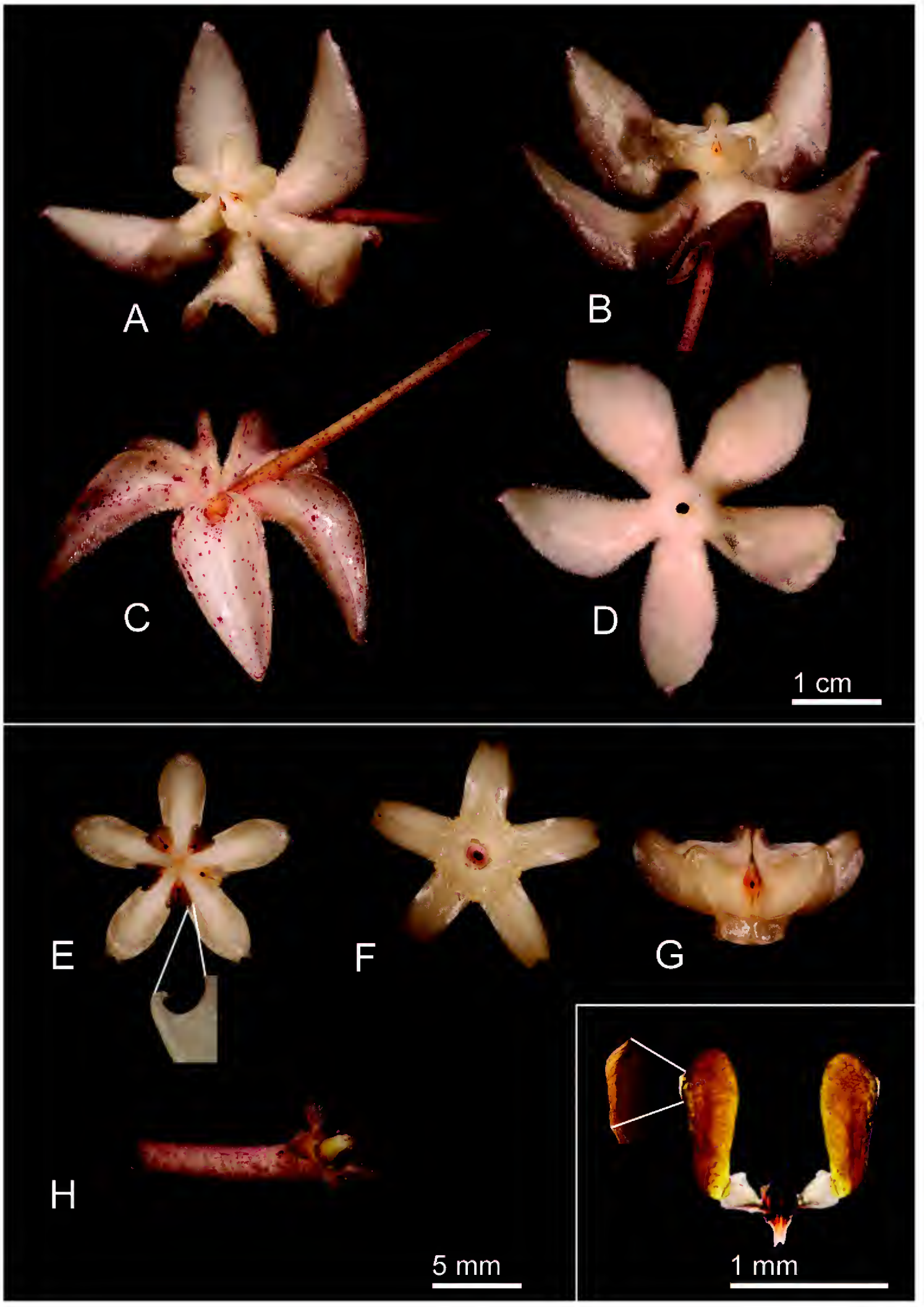

Fig. 2. *Hoya undulata* S.Rahayu & Rodda (from *M. Rodda MR650*, SING). **A, B, C.** Flower. **D.** Corolla after removing the corona. **E.** Corona, top view. **F.** Corona, from underneath. **G.** Corona, side view. **H.** Calyx and ovaries. **I.** Pollinarium with twin pollinia, with a magnification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

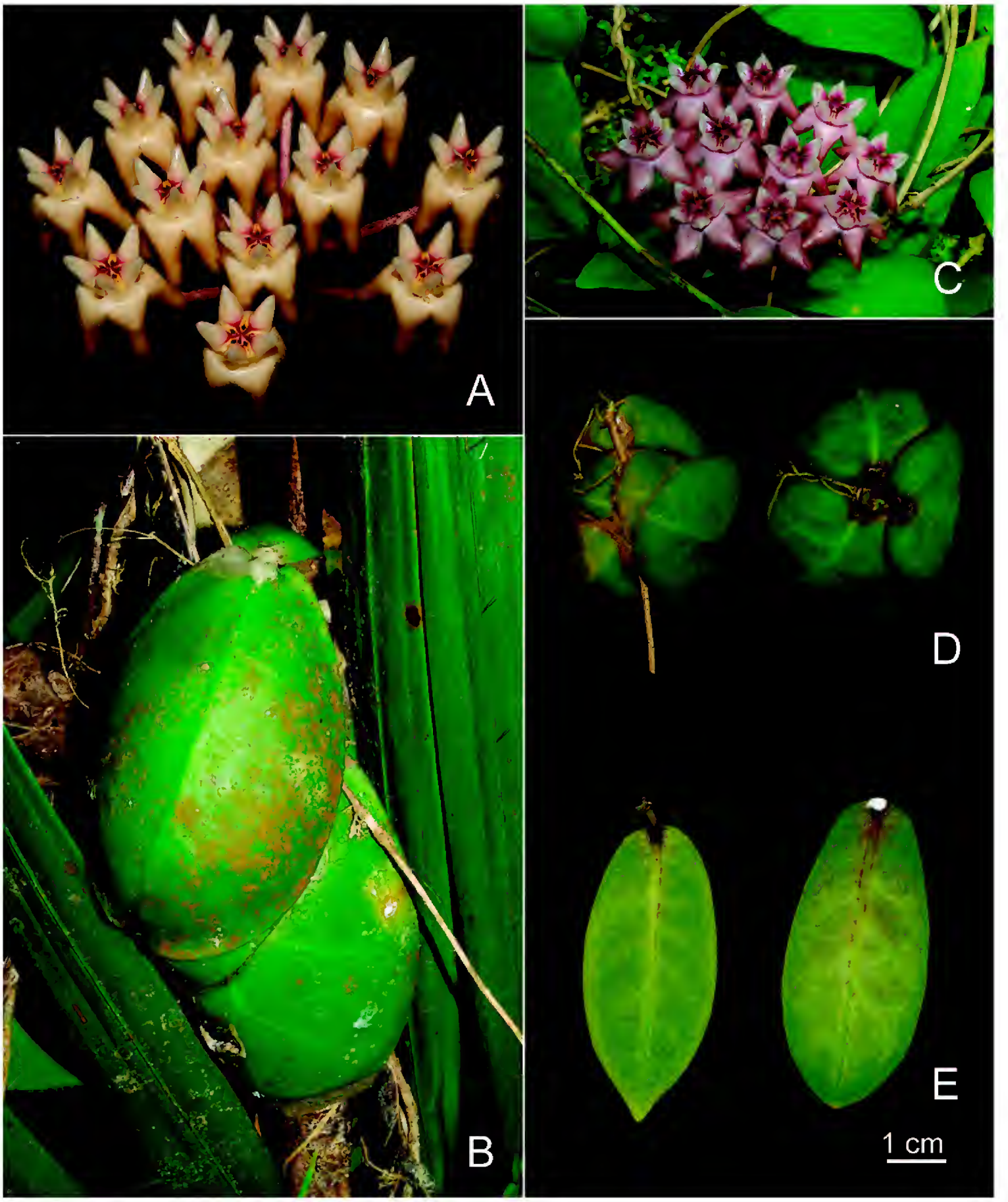

Fig. 3. *Hoya mitrata* Kerr (Photographed at Gunung Panti, Johor, Malaysia) **A.** Inflorescence. **B.** A small domatium. *Hoya darwinii* Loher (*M. Rodda MR421*, SING). **C.** Inflorescence. **D.** Domatia. **E.** Leaves not forming domatia. (Photos: Michele Rodda)

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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Begonia bimaensis, a new species of *Begonia* from Sumbawa Island, Indonesia

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ABSTRACT. A new species of *Begonia* sect. *Reichenheimea*, *B. bimaensis* Undaharta & Ardaka, is described from Mt Muria in Bima District, Sumbawa Island, Indonesia. The species is a narrow endemic, currently known from only one population, and has been assessed as Vulnerable using IUCN criteria.

Keywords. *Begonia*, Sumbawa, new species

Introduction

The pantropical genus *Begonia* L. is one of the largest genera of flowering plants, comprising more than 1700 species (Hughes, 2008 and the many species described since then). Southeast Asia is a hotspot of species diversity for *Begonia* (Hughes, 2008), with Indonesia being particularly rich in species and with many species still being discovered (Hughes, 2008; Thomas & Hughes, 2008; Girmansyah, 2009, 2012; Girmansyah et al., 2009; Hughes et al., 2009; Thomas et al., 2009, 2011; Ardi & Hughes, 2010; Wiriadinata, 2011; Ardi et al., 2013, 2014; Ardi, 2014; Lin & Peng, 2014). From these works the current estimate for the total number of *Begonia* species in Indonesia is 213 species.

There are only a few *Begonia* species recorded for Nusa Tenggara Barat (West Nusa Tenggara), and currently only two species have been reliably recorded from the largest island, Sumbawa (*B. multangula* Blume – Hughes & Pullan, 2007; and *B. muricata* Blume – Hughes, 2008). Examination of herbarium specimens shows that several endemic species remain to be described from the region. The lack of records for widely distributed species, such as *Begonia longifolia* Blume, may also reflect the poor documentation of the *Begonia* flora of Sumbawa, since we have seen herbarium material of this species from the surrounding islands of Bali, Lombok, Sumba and Timor.

During a fieldtrip to Sumbawa Island, a small population of an unknown *Begonia* from Mount Maria was found. Two living specimens were brought to the Bali Botanic Garden where they were cultivated. As these specimens could not be identified, the new species *Begonia bimaensis* is described here. *Begonia bimaensis* is placed in *Begonia* section *Reichenheimia* (Klotzsch) A.DC. as it exhibits the characters typical of the section: rhizomatous or tuberous stems, protandrous inflorescences, and three locular ovaries with entire placentae (Doorenbos et al., 1998).

All available *Begonia* specimens from the Herbarium of Bali Botanic Garden, BO, E, K, L and SING have been consulted and hence it must be assumed, at least until more intensive collecting in Sumbawa reveals otherwise, that the species described here has a very restricted range.

Species description

Begonia bimaensis Undaharta & Ardaka **sp. nov.** § *Reichenheimia*
Similar to *Begonia sendangensis* Ardi but differs in the dense white, long hairs on the adaxial surface of leaves (versus glabrous), female flower with four tepals (versus three) and the ovary with 3 wings, reddish, equal or subequal, locules 3, placentation axillary. Ovary characters for *Begonia sendangensis*, pinkish, equal, rounded at base, placentae axile. – TYPE: Cultivated at Bali Botanical Garden from vegetative material collected in the wild from Indonesia, West Nusa Tenggara, Sumbawa Island, Bima, Wawo, Ntori, Mt. Maria, 08°29′55″S 118°52′41″E, 525 m elev., 4 October 2010. Cultivated material vouchered and selected as type material on 11 December 2012 under *I Made Suja HK 1276* (holotype Herbarium Bali Botanic Garden; isotype BO). (Fig 1)

Perennial, tuberous, monoecious small herb, less than 10 cm tall. ***Stems*** very reduced, an elongated tuber 1.5–1.8 cm long, diameter 3–4 mm, internodes c. 1 mm long; stipules ovate to elliptic, c. 3 × 1–2 mm, pale green, apex projecting up to c. 6 mm long, persistent. ***Leaves*** alternate; petioles 3.5–7.5 cm long, red, sparsely covered with long pilose hairs c. 2–5 mm long; lamina basifixed, 4–6.5 × 2.5–5 cm, ovate to broadly ovate, asymmetric, base cordate, lobes not or rarely overlapping, apex acuminate, margin shallowly to moderately lobed, ciliate with a fringe of hairs; adaxial surface green to reddish green, densely covered with white pilose hairs, abaxial surface red, glabrous; venation palmate, red, primary veins 5–6, adaxially green to brownish, abaxially pale red. ***Inflorescence*** a simple dichasial cyme, few-flowered, axillary, protandrous, bisexual; peduncle 3–6 cm long, pink, glabrous; bracts minute, sub-orbicular, margin slightly fimbriate, deciduous. ***Male flowers***: pedicels 15–18 mm long; tepals 4, pink, glabrous, two outer tepals ovate to suborbicular, 8–14 × 8–11 mm, apex rounded, two inner tepals narrowly obovate, 5–12 × 4–6 mm, tip slightly obtuse, androecium yellow, symmetric, globose; stamens c. 40, filaments fused at base into short column c. 1 mm long, anthers c. 0.5 mm long, obovate, dehiscing through lateral slits more than half the length of the anther, apex slightly retuse. ***Female flowers***: pedicels 2.5–4 mm long, bracteoles present, with hairs, ovate, c. 2 mm long, persistent; tepals 4, pink, glabrous, two outer tepals suborbicular, c. 9.5–12 × 7.5–12.5 mm; glabrous, two inner tepals elliptic, c. 8–10 × 3.5–5 mm; ovary 3–4 × 4 mm (excluding wings), ellipsoid, glabrous, greenish white, locules 3, placentation axile, wings 3, equal or sub equal, reddish green triangular, widest point at the middle of the ovary, c. 1.5 mm long; stigma 3, U-shaped, stigmatic surface twisted. ***Fruit***: pedicel 2–5 mm long, capsule ovoid, 4–5 × 5–6.5 mm (excluding wings), dehiscent, splitting along the wing attachments, wing shape as for

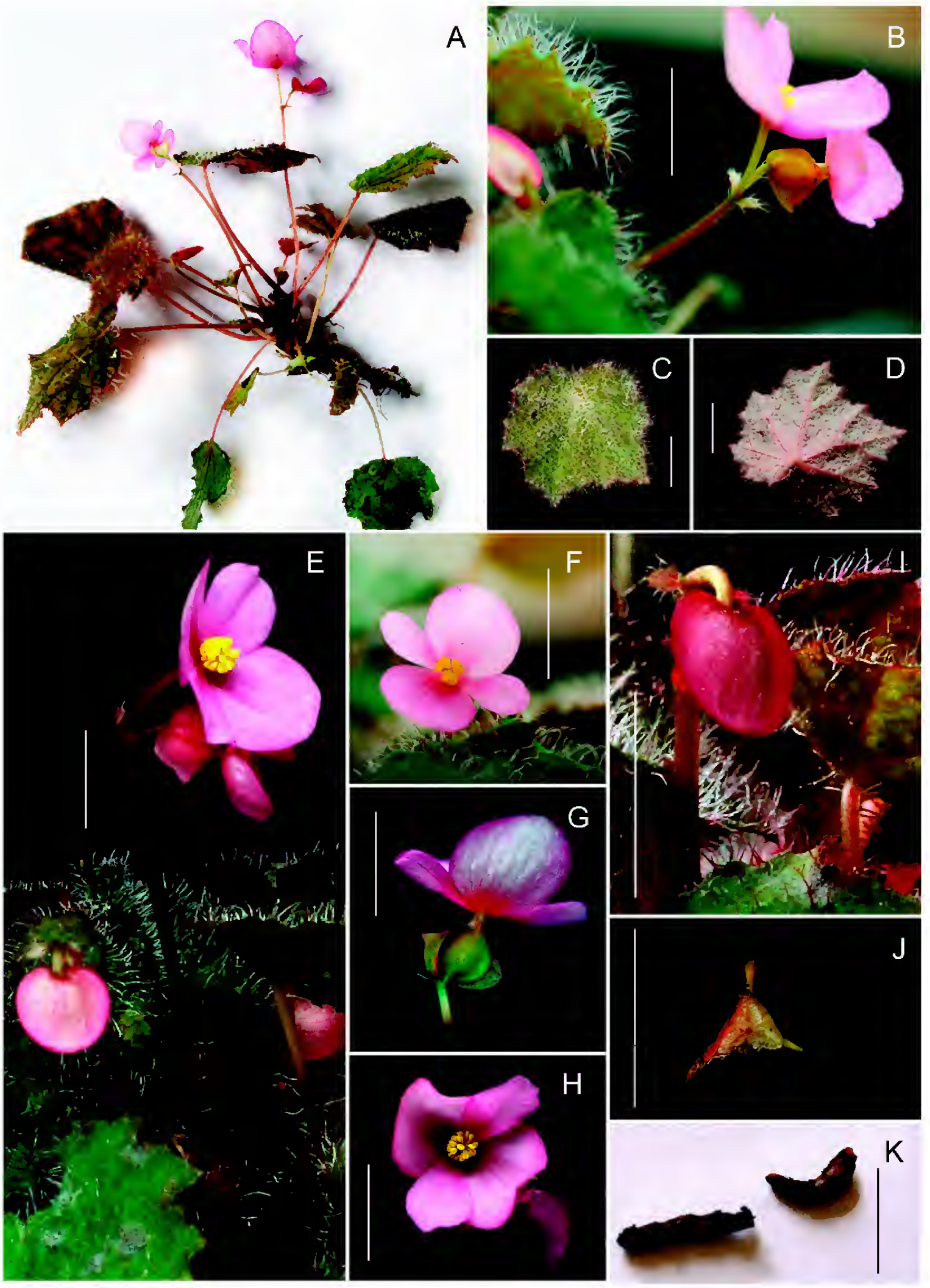

Fig. 1. *Begonia bimaensis* from cultivated material in Bali Botanic Garden. **A–B.** Habit; **C.** Leaf, adaxial surface; **D.** Leaf, abaxial surface; **E.** Inflorescence; **F.** Female flower; **G.** Female flower; **H.** Male flower; **I.** Bracts; **J.** Ovary transverse section; **K.** Tubers; Scale bars: 1 cm. (Photos: Gede Wawan Setiadi)

the ovary, wings widest subapically, 8 mm. ***Seeds*** numerous, brown, widely ellipsoid or ellipsoid, c. 0.35 mm long, 0.2 wide.

Distribution. Endemic to Mt Muria, Bima district, Sumbawa, West Nusa Tenggara, Indonesia.

Habitat. This species grows on steep rocky cliffs in shade, at c. 525 m altitude.

Preliminary IUCN conservation assessment. *Begonia bimaensis* is probably a narrowly endemic species, restricted to Mt Muria which is not formally protected. As the species is known only from a single population with a small number of individuals, a provisonal IUCN category of CR D is appropriate (IUCN, 2012).

Notes. The epithet '*bimaensis*' refers to the Bima district from where the type material was collected. *Begonia bimaensis* is unusual in *Begonia* section *Reichenheimia* in Indonesia on account of its tuberous habit, which is similar to *Begonia sendangensis*, a species recently described from the neighbouring island of Lombok (Ardi et. al, 2014). However, apart from the presence of tubers, the two species are morphologically dissimilar and *Begonia bimaensis* can easily be distinguished by the dense white long hairs on the upper surface of the leaves. The number of tepals in the female flower and the shape of the ovary wings provide further differences: The female flowers of *Begonia bimaensis* have four tepals whereas the female flowers of *B. sendangensis* have three tepals; in *B. bimaensis*, the shape of the wings in the ovary is very distinctive, being triangular and mostly cuneate at apex (versus rounded at base and truncate at the apex), reddish.

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A new species of *Paraboea* (Gesneriaceae) from Thailand

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ABSTRACT. A new species, *Paraboea maculata* C.Puglisi, is described. It is compared to similar species and the habitat on granite rocks, unusual for the genus, is highlighted.

Keywords. Gesneriaceae, *Paraboea*, Thailand

Introduction

A *Paraboea* (C.B.Clarke) Ridl. specimen, collected in fruit in Khao Khitchakut National Park in Chanthaburi, Thailand, in 2012, was recognised at the time as likely to be an undescribed species but was not published due to lack of flowering material. It has now flowered in the Royal Botanic Garden Edinburgh and is here described as a species new to science.

Paraboea was revised by Xu et al. (2008) but since then the genus has been considerably enlarged through the inclusion of *Trisepalum* C.B.Clarke and *Phylloboea* Benth. (Puglisi et al., 2011) and by the description of many more species (Chen et al., 2008; Kiew, 2010, 2012; Chen et al., 2012; Triboun & Middleton, 2012; Xu et al., 2012; Triboun, 2013; Wen et al., 2013). There are now over 130 species in the genus with many species being very locally endemic (Xu et al., 2008) which brings with it conservation concerns (Xu et al., 2008; Triboun & Middleton, 2012). The centre of diversity of the genus is in Thailand with over 75 species but it is likely that there are many undiscovered species in neighbouring countries.

Paraboea species are lithophytes, mostly on limestone substrates. A small number of species are recorded from other substrates, such as *Paraboea elegans* (Ridl.) B.L.Burtt (southern Thailand, Peninsular Malaysia) and *P. graniticola* Z.R.Xu (southern central Vietnam) from granite, and *P. pubicorolla* Z.R.Xu & B.L.Burtt and

Paraboea lavandulodora Triboun from sandstone. In *Paraboea* these are a small number of exceptions to the otherwise overwhelming preference for limestone. In Thailand this results in a very uneven distribution of the large number of species, with very few in the relatively limestone-poor areas of southeastern and northeastern Thailand.

In Xu et al. (2008) only one collection of a *Paraboea* species was reported from the southeastern province of Chanthaburi. No further collections from Chanthaburi were reported by Triboun & Middleton (2012) and Triboun (2013). Therefore, when a *Paraboea* species was collected from granite rocks in Khao Khitchakut National Park in Chanthaburi in 2012, it was only the second known collection of any species of the genus from the province and only the third collection from the whole southeastern region (the third collection being from the island of Ko Chang). The Khao Khitchakut plant has a terminal inflorescence with leaf-like bracts towards the base of the peduncle, characters which place the species in the *Paraboea martinii* group (Xu et al., 2008). When only known from the fruiting collection, it could already be determined that the Khao Khitchakut plant was not one of the described species in that alliance nor one of the other species recorded from the southeastern region by Xu et al. (2008). With the flowering material now available this is confirmed and the species is here described.

Paraboea maculata C.Puglisi, **sp. nov.**

Differs from other *Paraboea* species in the *Paraboea martinii* group, i.e. those with opposite leaves, campanulate corolla, twisted fruit and a terminal inflorescence, by the combination of a predominantly white and laterally compressed corolla, the purple spots at the base of the tube, the sticky glandular secretion on the bracts and calyx, and the winged petioles. – TYPE: Thailand, Chanthaburi, Khao Khitchakut, Khao Khitchakut National Park, Khao Phra Bhat, 12°50′14″N 102°10′3″E, 900 m, 27 August 2012, fr., *Middleton, D.J., Karaket, P., Suddee, S. & Triboun, P. 5675* (holotype E; isotypes BK, BKF). (Fig. 1)

Lithophytic, caulescent herb to 60 cm high. ***Stem*** short and erect, with an indumentum of sessile and stalked glands, and sparse multicellular, eglandular hairs. ***Leaves*** opposite, congested; petioles winged, 2–9 cm long, those of a pair forming a distinct auricle across the node; lamina lanceolate to ovate, 8–19 × 4–10 cm, about twice as long as wide, surface rugose, apex acute, base rounded and then shortly attenuate onto the wing of the petiole, margin irregularly crenate, indumentum arachnoid and deciduous above, with white glands and a pale, thin, interwoven, semi-deciduous indumentum below, secondary veins 10–13 pairs, tertiary veins reticulate, venation prominent below. ***Inflorescence*** a terminal panicle, 25–30 cm long, occasionally flanked by subterminal cymes, with at least 4 orders of branching, axes deep red-purple to bright brown, appearing chestnut brown in herbarium specimens, with a diffuse arachnoid indumentum or glabrous, bearing a series of sessile, leaf-like, opposite and decussate pairs of bracts of a progressively decreasing size, with internodes 5–15 cm long; uppermost bracts 0.4–1 cm long, 0.3–0.6 cm wide at the base, sessile, joined at

Fig. 1. *Paraboea maculata* C.Puglisi. **A.** Inflorescence. **B.** Winged petiole. **C.** Corolla, front view. **D.** Corolla and calyx, side view. (Photos: A, C, D: Lynsey Wilson; B: Sadie Barber)

the base or nearly so, deltoid, concave at the base, proximally red or brown, turning green towards the tip, densely covered in sessile glands and sticky on both sides but particularly so on the outer, which is glossy due to an exudate; pedicels 1–1.6 cm long, glabrous. ***Calyx*** with lobes divided to the base, resembling terminal bracts in colour, indumentum and glossiness; lobes 3–5 mm long, c. 1 mm wide, linear to narrowly lanceolate, apex broadly acute. ***Corolla*** strongly zygomorphic, campanulate, white with dark purple-red markings inside towards the base of the tube and around the staminode insertions, visible from the outer side, laterally and above as a pink shade; tube laterally compressed with the exception of two lateral bulges running along its length, ventrally with 3 narrower bulges, separated by two depressions, running to the base of the central lower lobe; covered in minute glandular hairs outside making the corolla sticky but without the glossy appearance of the bracts and calyx; tube 9–13 mm long, slightly oblique, mouth compressed; upper lobes 4–5 × 9–11 mm, elliptic; lateral lobes of the lower lip elliptic, apex obtuse, 5–8 × 5–6 mm; central lobe 6–10 × 4–9 mm (4 mm at the base widening to 9 mm), slightly folded around the central of the three bulges running along the tube, apex obtuse, margin undulate. ***Stamens*** arising from the base of the corolla; filaments 0.8–1 cm long, purple both proximally and distally, with a white to bright yellow knee in the middle, glabrous in the purple areas, densely covered in glandular hairs on the knee; anthers coherent, 1–2 × 3–3.5 mm, white, with the connectives and tips of the thecae tinged with purple; thecae strongly divergent; staminodes 3, white, the lateral ones 1–1.5 mm long, arising 1.5–2 mm above the base of the tube, with scattered glandular hairs along the filament, the central staminodes c. 0.5 mm long, arising c. 2.5 mm above the base of the tube, glabrous. ***Disc*** annular, pale yellow, c. 0.5 mm long. ***Gynoecium*** 11–12 mm long, glabrous; ovary 5–7 mm long, indistinctly developing into a c. 5 mm long style; style enantiostylous, apically bent, stigma reduced. ***Fruit*** (immature) a strongly twisted capsule, glabrous, green, 2–4 cm long, 1–1.5 mm diameter. ***Seeds*** numerous, ellipsoid, slightly compressed, 0.5–0.7 × 0.15–0.2 mm.

Distribution. Only known from the type locality

Ecology. Evergreen forest, on granite bedrock in deep shade.

Etymology. The epithet refers to the purple markings inside the corolla tube.

Provisional IUCN conservation assessment. Data Deficient (DD). This species is currently only known from one locality within a National Park. Although there is some disturbance due to tourism at this one site, it is uncertain how extensive these possible threats are. There is less than 400 km^2 of suitable habitat (forest of over 800 m altitude) in the immediate vicinity of the collection locality, which would suggest an assessment of Endangered based on a restricted Extent of Occurrence if there were corresponding threats. Similar forest types occur in neighbouring parts of Cambodia, where the threat levels are even less well known. Even if these forests are included, the EOO remains less than 2000 km^2, still within the boundaries of Endangered based

on EOO. However, a clearer assessment of the populations, the distribution and the threats would first have to be made before an accurate assessment could be proposed.

Additional specimens examined. THAILAND: **Chantanaburi:** Khao Khitchakut, Khao Khitchakut National Park, Khao Phra Bhat, *Middleton, D.J. et al.* 5675, cultivated as RBGE 20121417, vouchered 25 Jun 2014 as *Puglisi, C. CP250614/1* (E); ibidem, vouchered 15 July 2014 as *Atkins, H.J. 18* (SING).

*Notes.*This new species is unusual in being one of the very few species in the genus to occur on a substrate other than limestone. It quite clearly belongs in the *Paraboea martinii* group (Xu et al., 2008), which is characterised by opposite and decussate leaves, terminal inflorescence, reduced leaf-like bracts at the base of the peduncle, a large campanulate corolla, distinct limb, filaments with a bearded knee, and twisted capsules. Other species in this group include *Paraboea doitungensis* Triboun & D.J.Middleton, *P. glutinosa* (Hand.-Mazz.) K.Y.Pan, *P. paramartinii* Z.R.Xu & B.L.Burtt and *P. thorelii* (Pellegr.) B.L.Burtt. It differs from *Paraboea doitungensis* in the shorter calyx lobes, the flower colour, the laterally compressed corolla opening, the lateral swellings, and the longer fruit; it differs from *Paraboea glutinosa* in the broader leaves and the laterally compressed corolla opening; it differs from *Paraboea martinii* in the winged petiole, the lack of a matted or glandular indumentum on the floral axis and the compressed corolla; it differs from *Paraboea paramartinii* in the shorter petioles, the broader petiole wings and the more deeply crenate leaf margin; and it differs from *Paraboea thorelii* in the broader leaves, lack of glandular hairs on the inflorescence axes, laterally compressed corolla opening, calyx indumentum, and the pubescence on the upper leaf surface. We have also compared it to the material from Cambodia and Vietnam identified provisionally as *Paraboea cf. glutinosa* by Xu et al. (2008). It is not the same species as *Poilane 28717* from Cambodia, which has a different leaf indumentum, smaller upper bracts and calyx (but which is otherwise very similar to *Paraboea maculata* in shape and stickiness), very much larger lower bracts, and longer inflorescence internodes. It is also not the same species as *Poilane 16562* from Vietnam, which is an altogether hairier plant than *Paraboea maculata,* with bigger bracts and no visible glands.

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New orchid records for Myanmar, including the first record of the genus *Stereosandra*

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ABSTRACT. Nine orchid species, *Bulbophyllum capnophyton* J.J.Verm. et al., *Dendrobium macrostachyum* Lindl., *D. praecinctum* Rchb.f., *Habenaria reniformis* (D.Don) Hook.f., *Liparis distans* C.B.Clarke, *L. resupinata* Ridl., *Micropera thailandica* (Seidenf. & Smitinand) Garay, *Oberonia obcordata* Lindl. and *Stereosandra javanica* Blume, are reported as new for Myanmar. Of particular interest is the *Stereosandra* as it is the first record of this genus in the country.

Keywords. Myanmar, Orchidaceae, new distribution records

Introduction

The orchid flora of Myanmar is very rich but as yet poorly known (a brief overview of the current state of orchid floristics in the country is given in Ormerod & Sathish Kumar, 2003, 2008), and a complete inventory of all species of Orchidaceae found in the country is not yet available. Our ongoing studies resulted in nine additions to the orchid flora of Myanmar, namely *Bulbophyllum capnophyton* J.J.Verm. et al. (syn. *Trias nana* Seidenf.), *Dendrobium macrostachyum* Lindl., *D. praecinctum* Rchb.f., *Habenaria reniformis* (D.Don) Hook.f., *Liparis distans* C.B.Clarke, *L. resupinata* Ridl., *Micropera thailandica* (Seidenf. & Smitinand) Garay, *Oberonia obcordata* Lindl. and *Stereosandra javanica* Blume, all of which are new records for Myanmar of species found in adjacent countries. *Stereosandra* is recorded from Myanmar for the first time.

Brief descriptions, various notes and illustrations are provided for all species. Detailed locality data below the level of townships are not given here, in order not to reveal localities which may endanger their populations through over-collecting. The morphological descriptions are partly based on the specimens from Myanmar and have been partly extracted from previously published descriptions.

Enumeration of new records

1. *Bulbophyllum capnophyton* J.J.Verm., Schuit. & de Vogel, Phytotaxa 166: 110 (2014). – *Trias nana* Seidenf., Bot. Tidsskr. 71: 24 (1976); Seidenf., Opera Bot. 89:

164, fig. 106 (1986). – TYPE: Peninsular Thailand, Nam Yong, *Seidenfaden, G. & Smitinand, T. GT 6096* (holotype C). (Fig. 1A)

Bulbophyllum sp., Seidenf. & Smitinand, Orch. Thailand (Prelim. List): 388, fig. 294 (1961). Based on *A.F.G. Kerr 0361* (BK) from Thailand.

Herb to 2 cm tall, glabrous. ***Pseudobulbs*** spaced along a creeping rhizome at intervals of 10–14 mm, globular, somewhat flattened, 5–8 mm high, 6–10 mm in diameter, 1-leaved. ***Leaf*** sessile, fleshy, duplicate, oblong-lanceolate, acute, 10–21 mm long. ***Inflorescences*** 1-flowered, scape 1–2 mm long, pedicel and ovary c. 4 mm long, bract 1–2 mm long, hyaline, cup-shaped. ***Flowers*** light yellow, the lip deeper yellow. Sepals spreading, oblong-elliptic, acute, 5-veined, 7–8 × 2.3–3 mm. Petals narrowly ovate, acute, 1-veined, 2.5–3 × c. 1.5 mm; lip oblong, obtuse, 2.3–2.8 × c. 1 mm, with forward curved auricles at the base; column c. 1.7 mm long (excluding its anther process), stelids insignificant, anther process fleshy, oblong, somewhat spoon-shaped, c. 1.6 mm long, apex emarginate.

Distribution. Peninsular regions of Thailand and Myanmar.

Ecology and phenology. Very little habitat information on this species is available. The specimen from Myanmar was growing as an epiphyte at an elevation of about 400 m. In neighbouring Thailand the specimen *Kerr 0361* (BK) was collected in savanna (Seidenfaden & Smitinand, 1961: 388). In the distribution area of the species flowering has been recorded in November and January.

Material examined. MYANMAR. **Taninthayi Region:** Yebyu Township, 22 Nov 2012, *Saw Lwin, Pan Khet Khet & Zaw Oo Wai TNRO 162* (SING, SING [spirit], herbarium of Taninthayi Nature Reserve Education Centre).

Notes. The specimen from Myanmar, *Lwin et al. TNRO 162*, matches Seidenfaden's type very well in its structure (Seidenfaden, 1976a). However, it differs in the slightly larger size of the leaf and flowers: leaf 20–21 mm long (as opposed to 10–14 mm in the type); sepal c. 8 mm long (as opposed to c. 7 mm in the type); petal c. 3 mm long (as opposed to 2.5–2.8 mm in the type); lip c. 2.8 mm long (as opposed to 2.3–2.5 mm in the type). The epithet *nanum* was not available in *Bulbophyllum* when *Trias nana* was moved into it due to *Bulbophyllum nanum* De Wild.

2. *Dendrobium macrostachyum* Lindl., Gen. Sp. Orchid. Pl. 78 (1830). – *Callista macrostachya* (Lindl.) Kuntze, Revis. Gen. Pl. 2: 655 (1891). – TYPE: Sri Lanka, 1829, *Macrae, J. 17* (holotype K-LINDL! [K000364613]). (Fig. 2A)

Dendrobium stuartii F.M.Bailey, Proc. Roy. Soc. Queensland 1: 12 (1884); Vaddhanaphuti, Wild Orch. Thailand, ed. 4, 125, incl. colour photo (2005); Seidenf. &

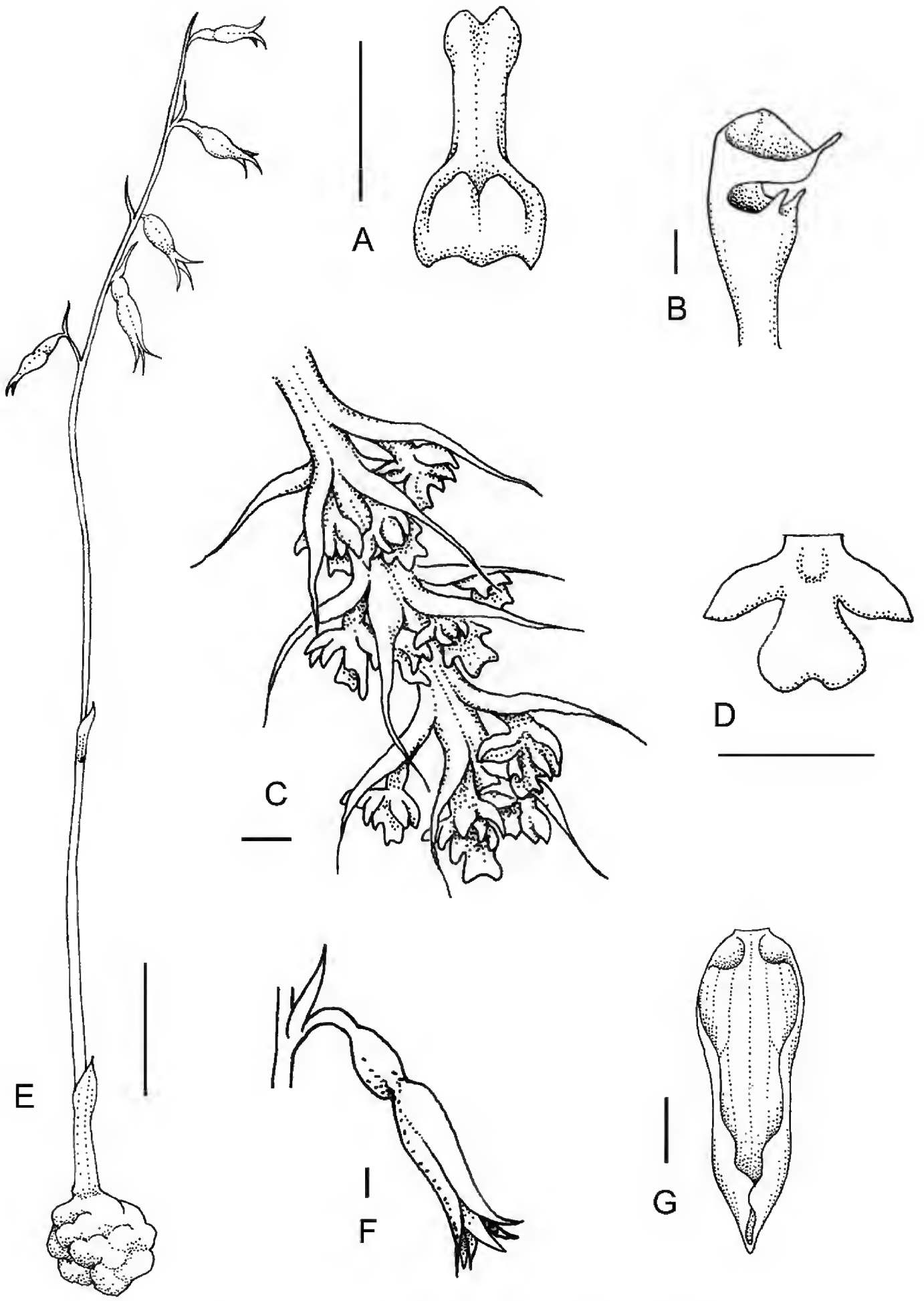

Fig. 1. A. Anther of *Bulbophyllum capnophyton* J.J.Verm., Schuit. & de Vogel. From *Lwin et al. TNRO 162*. **B.** Column of *Micropera thailandica* (Seidenf. & Smitinand) Garay. From *Lwin et al. TNRO 61*. **C**. Inflorescence of *Oberonia obcordata* Lindl. From *Kurzweil & Lwin KL 2664*. **D.** Lip of *Oberonia obcordata* Lindl. From *Kurzweil & Lwin KL 2664*. **E.** Habit of *Stereosandra javanica* Blume. From *Lwin et al. TNRO 5*. **F.** Flower of *Stereosandra javanica* Blume. From *Lwin et al. TNRO 5*. **G.** Lip of *Stereosandra javanica* Blume. From *Lwin et al. TNRO 5*. Scale bars: A–D, F–G = 1 mm, E = 20 mm. (Drawn by Joshua Yang)

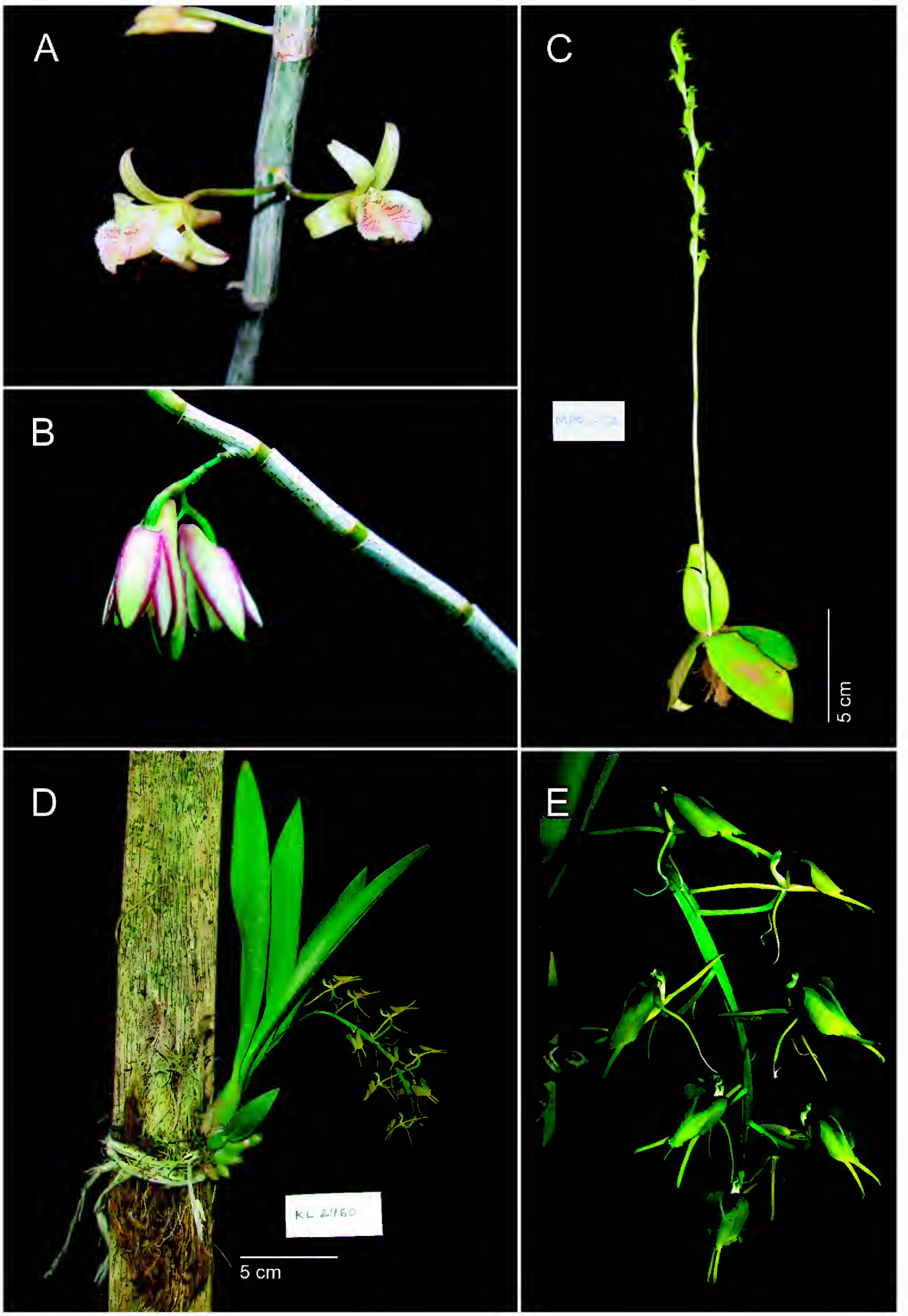

Fig. 2. A. *Dendrobium macrostachyum* Lindl. From *Lwin MPO 050.* **B.** *Dendrobium praecinctum* Rchb.f. From *Lwin SL 49.* **C.** *Habenaria reniformis* (D. Don) Hook.f. From *Lwin et al. MPO 020.* **D–E.** *Liparis distans* C.B.Clarke. *From Kurzweil & Lwin KL 2460* (Photos: Saw Lwin)

J.J.Wood, Orchids Penins. Malaysia Singapore 389, fig. 175, pl. 26d (1992). – *Callista stuartii* (F.M.Bailey) Kuntze, Revis. Gen. Pl. 2: 655 (1891). TYPE: Australia, drawing by R.D.Fitzgerald in *Austral. Orch.* 2(3): t. 6 (1888) (neotype designated by Clements, 1989).

Dendrobium tetrodon auct. non Rchb.f. ex Lindl.: Seidenf., Opera Bot. 83: 34, fig. 13 (1985).

Herb with slender pseudobulbous and sometimes almost wiry, pendulous stems to 70 cm long, glabrous except for the lip. ***Stems*** slightly zig-zagged, internodes 2–2.5 cm long, entirely covered by white membranous sheaths, leafy throughout. ***Leaves*** distichous, sessile, spreading, ovate to oblong-lanceolate, acute or acuminate, 4–8 × 0.9–2.5 cm. ***Inflorescences*** to 2.5 cm long, with 1–3(–4) flowers; bracts oblong-ovate, acute, 2.5–2.6 × 1.5–1.8 mm. ***Flowers*** 20–25 mm across, sepals and petals spreading or recurved; whitish to greenish yellow, lip with red-brown or purple veins on the side lobes, ageing to yellow; median sepal oblong-lanceolate, acute, 13–15 × 3.5–4 mm; lateral sepals similar but often slightly longer; mentum c. 6 mm long, narrowly conical; petals elliptic-lanceolate, acute or obtuse, as wide as the sepals, 13–15 × 3.5–4 mm; lip quadrately-ovate and very obscurely 3-lobed, 17–18 × c. 12 mm, unspurred, hairy particularly on the margin and midrib, basal part inrolled around the column, callus in the basal lip portion of three diverging ridges; column 3.5–4 mm long.

Distribution. Widespread in tropical Asia from Sri Lanka, India and the Himalayas to eastern Malesia; also found in northern Australia.

Ecology and phenology. The specimen from Myanmar was growing as an epiphyte on medium-sized road-side trees at an elevation of 1150 m. Elsewhere the species is found in wet and dry low-altitude and montane forest to 1220 m (Jayaweera, 1981; Seidenfaden & Wood, 1992). In the distribution area of the species flowering has been recorded in January and February.

Material examined. MYANMAR. **Mandalay Region:** Kyaukpadaung Township, Jan 2010, *Saw Lwin MPO 050* (SING, SING [spirit]). Very uncommon in this locality, growing in a small population of about 20 individuals.

Notes. A widespread species with rather small flowers in bunches of mostly 1–3 on leafless stem. The taxonomy of this species was previously disputed (Christenson & Wood, 2003), in particular its relationship to *Dendrobium aphyllum* (Roxb.) C.E.C.Fisch., but this has now been clarified (Schuiteman, 2011).

3. *Dendrobium praecinctum* Rchb.f., Gard. Chron., n.s., 7: 750 (1877); N.Pearce & P.J.Cribb, Fl. Bhutan 3(3): 416, pl. 23 [top right] (2002); Jin et al., Acta Bot. Yunnan. 32: 332 (2010). – *Callista praecincta* (Rchb.f.) Kuntze, Revis. Gen. Pl. 2: 655 (1891). TYPE: Unlocalised, cult. *Veitch s.n.* (holotype W). (Fig. 2B)

Dendrobium pauciflorum King & Pantl., J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 64: 332 (1895); Seidenf., Opera Bot. 83: 97, fig. 57, pl. XIIc (1985). – *Dendrobium sikkimense* A.D.Hawkes & A.H.Heller, Lloydia 20: 124 (1957), nom. illeg. – TYPE: India, Sikkim, July 1895, *Pantling, R. 172* (holotype K! [K000943939]).

Herb, pendent stems to 70 cm long, but often much shorter. ***Stems*** leafy in the distal half, branching from nodes in the upper part of the stem, internodes 1.4–4 cm long. ***Leaves*** distichous, to 12, lanceolate or linear-lanceolate, acute, sessile, 3–9 × 0.7–1.2 cm. ***Inflorescences*** axillary, arising from apical nodes of the leafless stem, with 1–5 flowers; floral bracts ovate, obtuse, c. 2 mm long. ***Flowers*** to 20 mm long, not opening widely; yellow to whitish yellow, sepals and petals with prominent purple marginal areas, midlobe and side lobes of lip with red spots; pedicel and ovary 5–10 mm long; median sepal lanceolate or lanceolate-ovate, obtuse, 3–10 × up to 4 mm; lateral sepals ovate, weakly falcate, keeled, 4–10 × 2–4 mm; petals lanceolate-ovate, usually ciliolate, 4–10 mm long and up to 3 mm wide; lip rather deeply 3-lobed, somewhat clawed, 4–12 × 3–8 mm, hispid-fimbriate on the margins; lateral lobes narrow, tooth-like; mid-lobe oblong, flat; disk with three prominent, thickened veins; column broad, with a foot 2–7 mm long.

Distribution. Northeastern India and eastern Himalayas to Myanmar, Thailand and southwestern China (Yunnan).

Ecology and phenology. Habitat information of the specimen from Myanmar has not been recorded. In Sikkim and Bhutan the plants are epiphytic in evergreen broad-leaved forest at elevations ranging from 1000 to 1330 m, and rarely up to 1850 m (Pearce & Cribb, 2002). In the distribution area of the species flowering has been recorded in June and July.

Material examined. MYANMAR. **Shan State:** Ho Pone Township, 2011, *Saw Lwin SL 49* (herbarium of the Myanmar Floriculturist Association).

Notes. Easily recognised by the prominent purple edges on the pale yellow flowers and the rather deeply 3-lobed lip which is strongly hairy to fringed on the margins. As far as we are aware no vouchered record of the occurrence of *Dendrobium praecintum* in Myanmar has previously been made. However, a photograph of an unidentified *Dendrobium* species from Putao in northern Kachin State was published by Nyan Tun (2014: 254) and was later referred to this species by Paul Ormerod (pers. comm.). Interestingly, the distribution 'Myanmar' was also listed in a publication newly reporting *Dendrobium praecinctum* in Yunnan, China (Jin et al., 2010), but no specimen from Myanmar was cited and therefore this listing appears to be based on a sight-record only.

4. *Habenaria reniformis* (D.Don) Hook.f., Fl. Brit. India 6: 152 (1890); Seidenf., Dansk Bot. Ark. 31(3): 132, fig. 85 (1977); S.C.Chen & P.J.Cribb in Z.Y.Wu et al. (eds), Fl. China 25: 149 (2009); Kurzweil, Fl. Thailand 12(1): 133, fig. 76 (2011). – *Listera reniformis* D.Don, Prodr. Fl. Nepal.: 28 (1825). – *Neottia reniformis* (D.Don) Spreng., Syst. Veg. 3: 707 (1826). – TYPE: Nepal, 1821, *Wallich, N. 7067* (lectotype K-W!, designated by Seidenfaden (1977)). (Fig. 2C)

Habenaria clovisii Gagnep., Bull. Soc. Bot. France 78: 68 (1931). – TYPE: Cambodia, Stung-streng, 1866–1868, *Thorel, C. 2143* (syntypes P! [P00439699, P00439700]); Vietnam, near Dalat, 17 Oct 1924, *Evrard, F. 1480* (syntype P! [P00439698]).

Herb to 20 cm tall, glabrous. ***Tubers*** globose to oblong, to 1 cm in diameter, fleshy. ***Stems*** slender, wiry, to 1 mm in diameter. ***Leaves*** 2–4, basal and adpressed to the substrate, orbicular, elliptic or ovate, acute or obtuse, 1.4–4 × 1–2.7 cm. ***Inflorescences*** lax, with 3–7(–10) flowers; with or without a spreading amplexicaul leafy bract near the base; sterile bracts 4–6(–9), mostly erect, lanceolate, acuminate, 0.5–1.8 cm long; rachis 3–8 cm long; floral bracts lanceolate or ovate-lanceolate, acuminate, 7–10 × 1.5–2 mm, much shorter than the ovary. ***Flowers*** 6.5–9 mm in diameter, resupinate; green, greenish-white, yellow-green or brownish; ovary twisted mainly in its basal portion, cylindric-fusiform, indistinguishable from the pedicel, 13–18 mm long; median sepal erect, concave, ovate or ovate-oblong, obtuse, 3-veined, 3.5–4(–5) × 1.5–3 mm; lateral sepals spreading or reflexed, obliquely ovate-lanceolate, subacute or acute, 3-veined, 3.5–4(–6) × 1.7–3.4 mm; petals forming a hood with the median sepal, falcately elliptic-lanceolate or linear-triangular, subacute or obtuse, 1-veined, 3–4.5 × 0.8–1.6 mm, sometimes widened at the base; lip 4.5–10 mm long, either unlobed and linear, or 3-lobed with filiform side lobes to 29 × 0.1–0.3 mm; spur either present or absent, if present saccate or cylindric and to 7.6 mm long; column 1–2.3 mm long; anther canals insignificant; stigmas subcylindric or clavate, 1.5–2 mm long. ***Capsule*** fusiform-elliptic, 9.5–10 × 2.2–3 mm.

Distribution. India and Nepal to Indochina and southern China; also recorded from northern Sumatra.

Ecology and phenology. No ecological information on the specimens from Myanmar is available except that the species grows terrestrially. Elsewhere found in grassy places in forests, in bamboo thicket and scrubland at elevations ranging from 150 to 825 m, sometimes also in cracks of limestone rocks (Chen et al., 2009; Kurzweil, 2011). In the distribution area of the species flowering has been recorded in August, October and November.

Material examined. MYANMAR. **Mandalay Region:** Kyaukpadaung Township, 26 Oct 2009, *Saw Lwin, Pan Khet Khet & Sandar Maung MPO 020* (SING). Growing in a small population.

Notes. Habenaria reniformis is characterised by small greenish or brownish flowers with sepals mostly less than 4.5 mm long. The lip shape is variable, ranging from entire to 3-lobed (Banerji & Pradhan, 1984: 36; Chen et al., 2010: 193; Baretto et al., 2011: 260), and the spur can be absent or cylindrical and up to 7.6 mm long (Seidenfaden, 1977: 133; Kurzweil, 2011: 133; Baretto et al., 2011: 260). The rather robust anther and the long protruding stigmas are characteristic of the species (Seidenfaden, 1977).

In the collection from Myanmar, *Lwin et al. MPO 020*, the petals are basally widened to more than double their width above. The petals and the lip are basally united with the column. The lips of the two plants in this collection are mostly unlobed. The only exception is one flower which has an asymmetric 3-lobed lip and appears to be abnormally developed: one side lobe is linear-filiform and 4 mm long, and the other one semicircular and only 0.5 mm long.

Habenaria reniformis is very close to *H. humidicola* Rolfe and *H. poilanei* Gagnep., both of which differ by having larger leaves, consistently deeply 3-lobed lips and longer spurs. The *Habenaria diphylla* (Nimmo) Dalzell group is also very close. The relationships among these species are not fully resolved and it is not yet clear if all of these taxa can be maintained as separate species. As already noted by Seidenfaden (1977), further research is needed to reach a final position on their status.

5. *Liparis distans* C.B.Clarke, J. Linn. Soc., Bot. 25: 71 (1889); Seidenf., Dansk Bot. Ark. 31(1): 76, fig. 50 (1976); N.Pearce & P.J.Cribb, Fl. Bhutan 3(3): 212 (2002); S.C.Chen et al. in Z.Y.Wu et al. (eds), Fl. China 25: 225 (2009). – *Leptorkis distans* (C.B.Clarke) Kuntze, Revis. Gen. Pl. 2: 671 (1891). – *Stichorkis distans* (C.B.Clarke) Marg., Szlach. & Kulak, Acta Soc. Bot. Poloniae 77: 38 (2008). – TYPE: India, Nagaland, Kohima, 21 Oct 1885, *Clarke, C.B. 41071* (syntype K! [K000387820], CAL); Kohima, *Clarke, C.B. 41099* (syntype K, not found); Kohima, 21 Oct 1885, *Clarke, C.B. 41105* (syntype K! [K000387819]); Kohima, 21 Oct 1885, *Clarke, C.B. 41574* (syntype K! [K000387821]). (Fig. 2D–E)

Liparis macrantha Hook.f., Hooker's Icon. Pl. 19: t. 1854 (1889). – TYPE: India, Nagaland, *Prain, D. 44* (lectotype K, designated by Seidenfaden (1976b)).

Liparis yunnanensis Rolfe, J. Linn. Soc., Bot. 36: 8 (1903). – TYPE: China, Yunnan, *Henry, A. 10485* (holotype K! [K000364665]).

Liparis oxyphylla Schltr., Repert. Spec. Nov. Regni Veg. Beih. 4: 63 (1919). – TYPE: China, Yunnan, *Henry, A. 12593* (lectotype K! [K000364666], designated here; isolectotype E! [E00286229]).

Herb mostly 20–40 cm tall, pseudobulbous, glabrous. ***Pseudobulbs*** clustered, subcylindric or narrowly ovoid, 2–6(–9.5) cm long, slightly compressed. ***Leaves*** 2, distichous, shortly and indistinctly petiolate, articulate, spreading, narrowly oblanceolate, acute or acuminate, 15–35 × 1–2.8 cm. ***Inflorescences*** arcuate or

pendulous, 15–39 cm long, lax, with up to 12 distant flowers; peduncle somewhat compressed, narrowly winged, with 2–3 sterile bracts; floral bracts narrowly triangular, 6–12 mm long. ***Flowers*** medium-sized, olive-green to dull yellow; pedicel and ovary 14–22 mm long; sepals narrowly lanceolate, obtuse, mostly 10–16 × 3–5 mm, margins often revolute; petals linear-filiform, obtuse, 10–16 × c. 2 mm; lip ovate, obovate or elliptic, 10–14 × 10–11 mm, basal part a short claw, margin irregularly denticulate, rounded or obtuse at the apex, with a 2-lobed callus at the base, unspurred; column arcuate, 5–6 mm long, narrowly winged in the upper part. ***Capsule*** ellipsoid or narrowly obovoid-oblong, 12–18 × 6–7 mm.

Distribution. Widespread from northeastern India and the eastern Himalayas to Myanmar, Indochina and southwestern and southern China. Also in the Philippines.

Ecology and phenology. The specimen from Myanmar was growing as an epiphyte in primary mountain forest. Elsewhere the species is lithophytic or epiphytic in various forest types at elevations up to 2400 m (Chen et al., 2009). In Vietnam often found in limestone regions (Averyanov, 2013). In the distribution area of the species flowering has been recorded between September and February.

Material examined. MYANMAR. **Kachin State:** Border region of Putao and Nogmung Townships, 7 Mar 2007 (fruiting at the time of collection; flowering in cultivation), *Kurzweil, H. & Saw Lwin KL 2460* (herbarium of the Myanmar Floriculturist Association).

Notes. Distinct with its large flowers in lax inflorescences and the wide lip with denticulate margins.

6. *Liparis resupinata* Ridl., J. Linn. Soc., Bot. 22: 290 (1886); Seidenf., Dansk Bot. Ark. 31(1): 88, fig. 60 (1976); N.Pearce & P.J.Cribb, Fl. Bhutan 3(3): 209, pl. 7 [top right] (2002); S.C.Chen et al. in Z.Y.Wu et al. (eds), Fl. China 25: 228 (2009). – *Leptorkis resupinata* (Ridl.) Kuntze, Revis. Gen. Pl. 2: 671 (1891). – *Platystyliparis resupinata* (Ridl.) Marg., Richardiana 7: 39 (2007). – TYPE: India, Darjeeling, 1844, *Griffith, W. s.n.* (syntype K-LINDL! [K000873787]); India, Khasia, *sine collector 986* (syntype K-LINDL! [K000873786]); India, Khasia, *Griffith, W. s.n.* (syntype K-LINDL! [K000873788]); India, Sikkim, 5000 ft [1524 m], *Hooker, J.D. 90* (syntype K-LINDL! [K000873785]); India, Khasia, *Lobb, T. 122* (syntype K-LINDL! [K000873784]); India, Khasia, *Hooker, J.D. & Thompson, T. 90* (syntype K-LINDL! [K000873783]). (Fig. 3A–B)

Liparis ridleyi Hook.f., Hooker's Icon. Pl. 19: t. 1887 (1889). – *Leptorkis ridleyi* (Hook.f.) Kuntze, Revis. Gen. Pl. 2: 671 (1891). – TYPE: India, Sikkim, 3000–5000 ft [914–1524 m], *Hooker, J.D. 89* (syntype K-LINDL! [K000873782]); India, Sikkim, *Hooker, J.D. s.n.* (syntype K-LINDL! [K000387829]); *Griffith's collector, Kew Distr. 5081* (syntype K); India, Darjeeling, 5500 ft [1676 m], 11 Mar 1875, *Clarke, C.B.*

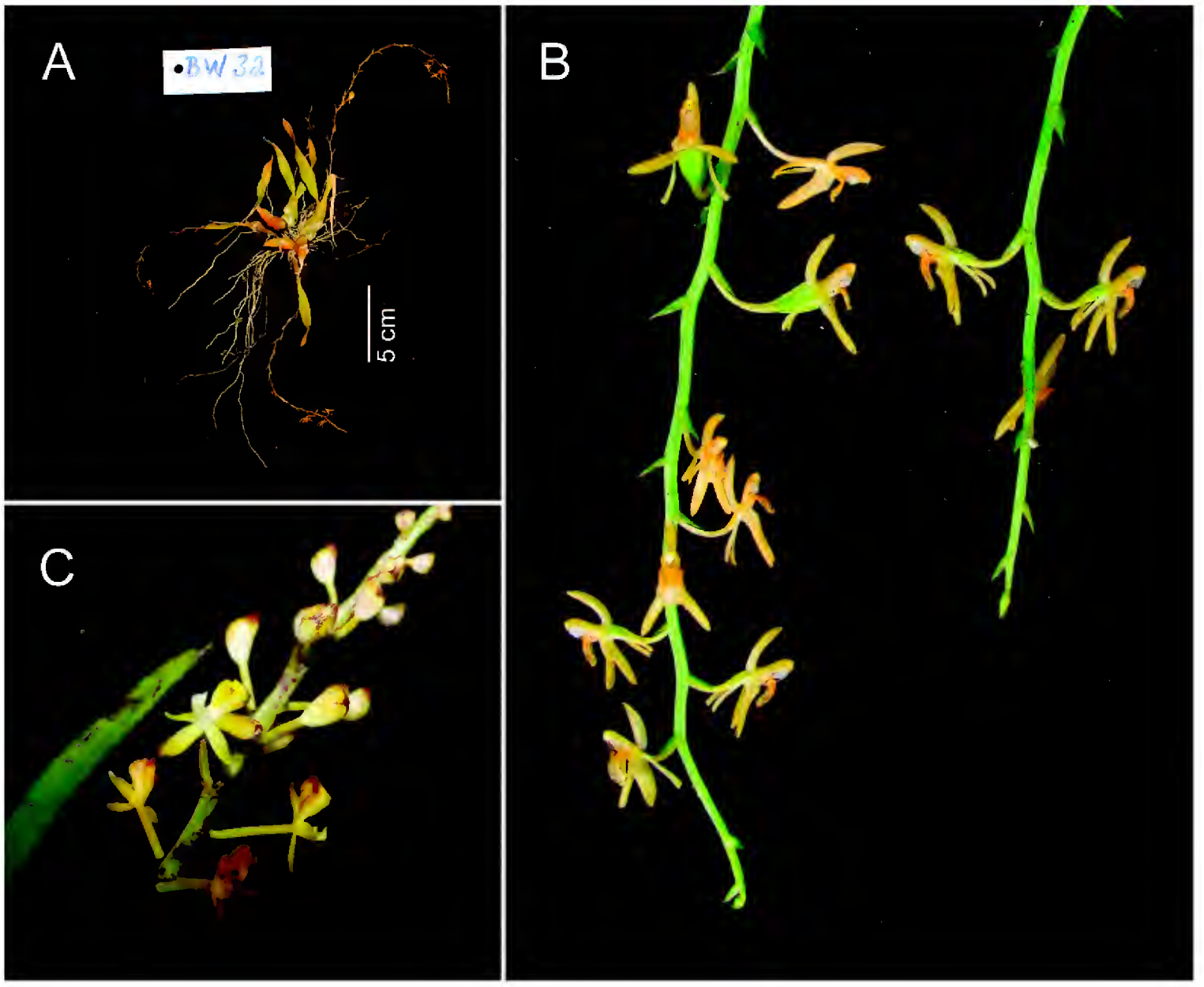

Fig. 3. A–B. *Liparis resupinata* Ridl. From *Lasi Bawk Naw BW 32*. **C.** *Micropera thailandica* (Seidenf. & Smitinand) Garay. From *Lwin et al. TNRO 61* (Photos: A, H. Kurzweil; B–C, Saw Lwin)

27235 (syntype K-LINDL! [K000387827]; India, Darjeeling, 5000 ft, [1524 m], 2 Mar 1876, *Clarke, C.B. 27088* (syntype K-LINDL! [K000387828]).

Herb 12–28 cm tall, with densely arranged pseudobulbous stems. ***Pseudobulbs*** 1.5–5 × 0.3–0.6 cm, made up of a few nodes, with leaves in the upper half. ***Leaves*** 2–4, papery, subsessile, narrowly oblong to linear-lanceolate, acute to acuminate, 6–13 × 0.4–1.2 cm, articulate. ***Inflorescences*** arching or pendent, lax, 10–50-flowered; peduncle slightly zig-zagged, 5–8 cm long, with several sterile bracts 0.5–0.9 cm long; rachis 8–18 cm long; floral bracts lanceolate, acute, concave, 3–5 × 1–1.5 mm. ***Flowers*** to 2 mm wide and 5 mm high when seen from the front; in the specimen from Myanmar pale greenish orange-yellow with orange on the basal part of the lip including its auricles, in other parts of the distribution area reported as pale green, greenish yellow, golden brownish or creamy; pedicel and ovary 5–7 mm long; sepals subequal, spreading, oblong or elliptic-oblong, obtuse or acute, 1-veined, 3–4 × 1–1.8 mm; petals reflexed downwards, narrowly linear, obtuse, 2–3.5 × c. 0.3 mm; lip knee-

like, bent with the lower portion erect and parallel to the column and the distal portion spreading forwards, broadly elliptic-oblong or broadly ovate-oblong, 2.5–3 mm long, unspurred, base auriculate and with a bilobed callus, apex obtuse, margins incurved, forming a pouch; column erect, 1–2.8 mm long, with two suborbicular wings, each with a prominent pendulous filiform appendage. ***Capsule*** obovoid-oblong, c. 5 × 2–3 mm.

Distribution. India and Himalayas to Indochina and southwestern China (Xizang and Yunnan). Also recorded in the Gaoligongshan Mountains in western Yunnan Province (Jin et al., 2009), which is very close to where our specimen from Myanmar was collected.

Ecology and phenology. The specimen from Myanmar was growing as an epiphyte in degraded mixed broad-leaved forest with much bamboo and moss-covered trees at an elevation of 2100 m. Elsewhere the species is found in evergreen broad-leaved and coniferous forest from 1500 to 2500 m (Pearce & Cribb, 2002; Chen et al., 2009; Averyanov, 2013). In the distribution area of the species flowering has been recorded from October to March.

Material examined. MYANMAR. **Kachin State:** Waingmaw Township, 10 Mar 2011, *Stephen Lasi Bawk Naw BW 32* (herbarium of the Myanmar Floriculturist Association). Locally common.

Notes. One of the epiphytic *Liparis* species with few-leaved pseudobulbs. Well-characterised by the shape of the small flowers that have a broadly oblong lip with an obtuse and pouched apex and the column with characteristic pendulous filiform appendages on the wings.

7. *Micropera thailandica* (Seidenf. & Smitinand) Garay, Bot. Mus. Leafl. 23: 187 (1972); Seidenf., Opera Bot. 95: 126, fig. 72 (1988); Vaddhanaphuti, Wild Orch. Thailand, ed. 4, 186, incl. colour photo (2005). – *Camarotis thailandica* Seidenf. & Smitinand, Orch. Thailand (Prelim. List) 712, fig. 529 (1965). – TYPE: Thailand, Satun Province, Feb 1961, *Seidenfaden, G.& Smitinand, T. GT 4118* (holotype C). (Fig. 1B, 3C)

Herb with monopodial growth. ***Stems*** to 30 cm long, glabrous, covered by the dark, rugose bases of the leaves. ***Leaves*** about 10, distichous, spaced at intervals of about 2 cm, flat, conduplicate, oblong-linear, apex unequally bilobed with rounded lobes, 8–15 × 1–1.5 cm, fleshy. ***Inflorescences*** 17–23 cm long, several-flowered; peduncle 10–15 cm long, with 2–3 sheathing sterile bracts 0.3–0.4 cm long; rachis 8–10 cm long, unbranched; bracts broadly triangular, obtuse, 2–2.5 × c. 4 mm, fleshy. ***Flowers*** yellow or light orange-yellow, lip base sometimes white, sepals sometimes tipped with brown, column white or cream; median sepal elliptic-ovate, apex broadly rounded,

to 9 × 3.5 mm, concave, fleshy; lateral sepals similar but somewhat shorter and wider, adnate to the column-foot; petals elliptic-lanceolate, acute, to 8 × 3.3 mm; lip 7 mm long, deeply boat-shaped with a conical spur 4–5 mm long in its distal part, obscurely 3-lobed, very fleshy; midlobe triangular, c. 2 × 2–2.5 mm; side lobes inconspicuous, broadly triangular, edges minutely serrate; callus a triangular tongue at the base of the midlobe, split at the end, below this a rounded callus at the backwall of the spur (terminology after Seidenfaden, 1988); spur with a longitudinal septum; column c. 6 mm long, ventrally with a sudden horizontal edge with two short lateral horns below the stigma, above which the column narrows to about one half of its width below, higher up widening again under the anther and the rostellum, rostellum beak c. 2 mm long, not or only slightly twisted.

Distribution. Myanmar, Thailand and Vietnam.

Ecology and phenology. The specimen from Myanmar was found in primary evergreen forest at about 220 m, growing as an epiphyte on tall trees. In Thailand recorded at elevations of between 700 and 1000 m (Seidenfaden, 1988). In the distribution area of the species flowering has been recorded in February and March.

Material examined. MYANMAR. **Taninthayi Region:** Yebyu Township, 712 ft [217 m], 25 Mar 2012, *Saw Lwin, Pan Khet Khet & Zaw Oo Wai TNRO 61* (SING, SING [spirit], herbarium of the Myanmar Floriculturist Association). Locally common.

Notes. This species is unmistakable in its lip and column structure. It is known from several collections in Thailand and is also found in Vietnam; in addition it is here newly reported for Myanmar. Seidenfaden & Smitinand (1965) compared it with the Malaysian *Camarotis adnata* (Ridl.) Holttum (now included in *Micropera fuscolutea* (Lindl.) Garay), which is superficially similar, but this species differs in details of its lip and column (Seidenfaden & Wood, 1992).

8. *Oberonia obcordata* Lindl., Fol. Orchid. 8: 7 (1859); Seidenf., Dansk Bot. Ark. 33(1): 30, fig. 19 (1978); N.Pearce & P.J.Cribb, Fl. Bhutan 3(3): 230 (2002); S.C.Chen et al. in Z.Y.Wu et al. (eds), Fl. China 25: 240 (2009). – *Malaxis obcordata* (Lindl.) Rchb.f. in W.G.Walpers, Ann. Bot. Syst. 6: 216 (1861). – *Iridorkis obcordata* (Lindl.) Kuntze, Revis. Gen. Pl. 2: 669 (1891). – TYPE: India, Sikkim, *Hooker, J.D. & Thompson, T. 112* (syntype K-LINDL! [K000974237]); India, Darjeeling, 1844, *Griffith, W. s.n.* (syntype K-LINDL! [K000974238]); India, Khasia, *Griffith, W. s.n.* (syntype K-LINDL! [K000974231]). (Fig. 1C–D, 4A)

Oberonia treutleri Hook.f., Hooker's Icon. Pl. 18: t. 1786 (1888). – *Iridorkis treutleri* (Hook.f.) Kuntze, Revis. Gen. Pl. 2: 669 (1891). – TYPE: India, Sikkim, 6000 ft [1829 m], 1 Dec 1874, *Treutler, W.J. 1151* (holotype K! [K000387726]).

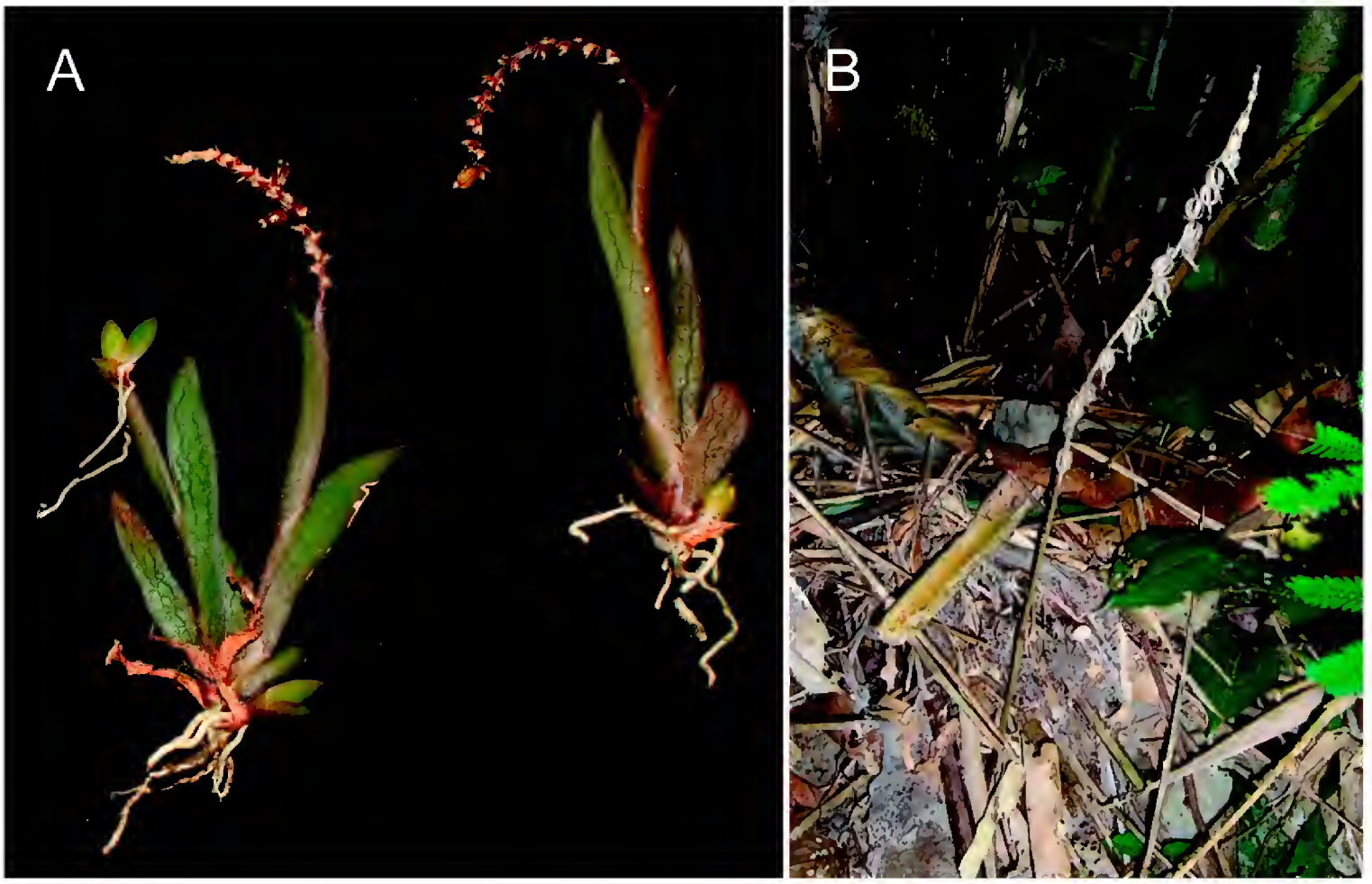

Fig. 4. A. Fruiting specimens of *Oberonia obcordata* Lindl. From *Lasi Bawk Naw BW 8*. **B.** Fruiting specimen of *Stereosandra javanica* Blume in its natural habitat in southern Myanmar. From *Lwin et al. TNRO 5* (Photos: A, H. Kurzweil; B, Saw Lwin)

Herb to 9 cm tall, with leafy stems to 4 cm tall, glabrous. ***Leaves*** (3–)5–8, distichous, equitant, bilaterally compressed, fleshy, linear-oblong, slightly falcate, acute to acuminate, mostly 1.5–5 × 0.5–0.9 cm, base not articulate. ***Inflorescences*** terminal, densely or subdensely many-flowered, 4.5–7.5 cm long; peduncle connate to lower part of uppermost leaf and therefore appearing to arise from its blade, with few to many erect sterile bracts about 0.5 cm long; rachis slender, 1.5–6 cm long; floral bracts verticillate, lanceolate or ovate-lanceolate, apex acuminate-caudate, 2–4 mm long, much longer than the flowers, margin slightly erose. ***Flowers*** 1–1.5 mm in diameter; reddish brown or red; pedicel and ovary 0.5–1.5 mm long; median sepal ovate, acute, to 1.1 × 0.6 mm; lateral sepals broadly ovate, obtuse, to 1.1 × 1 mm; petals linear-oblong, subacute, to 0.9 × 0.5 mm; lip 3-lobed, not spurred, to 1.6 mm long; side lobes divergent, ovate-oblong, obtuse, to 0.5 mm long; midlobe obcordate or reniform, emarginate, to 1 × 0.8 mm, with a prominent basal callus; column to 0.5 mm long. ***Capsule*** ovoid, to 5 × 4 mm.

Distribution. Himalayas, northeastern India, Myanmar and southwestern China to Thailand.

Ecology and phenology. The specimens from Myanmar were found in forest at various elevations (see below). Elsewhere either epiphytic or lithophytic, usually at elevations

up to 3000 m (Pearce & Cribb, 2002; Chen et al., 2009). In the distribution area of the species flowering has been recorded between July and December and in March. Flowering and fruiting plants can sometimes be found at the same time.

Material examined. MYANMAR. **Kachin State:** Putao Township, undisturbed evergreen forest, 1500 m, 21 Mar 2009, *Kurzweil, H. & Saw Lwin KL 2664* (SING); Waingmaw Township, degraded mixed forest, 2200-2300 m, 9 Mar 2011, *Stephen Lasi Bawk Naw BW 8* (RAF, herbarium of the Myanmar Floriculturist Association). Locally common in both localities.

Notes. Very distinct due to the inflorescence which is connate to the uppermost leaf, the long and whorled floral bracts, and the small flowers with their large lip side lobes and the basal lip callus.

9. Stereosandra javanica Blume, Mus. Bot. 2: 176 (1856); Seidenf., Dansk Bot. Ark. 32(2): 173, fig. 107 (1978); Hedge & Rao, Indian J. Forest. 10(3): 196 (1987); Seidenf. & J.J. Wood, Orchids Penins. Malaysia Singapore 143, fig. 60 (1992); N.Pearce & P.J.Cribb, Fl. Bhutan 3(3): 582 (2002); S.C.Chen et al. in Z.Y.Wu et al. (eds), Fl. China 25: 207 (2009); H.A.Pedersen, Fl. Thailand 12(2): 632, fig. 342 (2014). – TYPE: Western Java, Bantam Province, *Kuhl, H. & van Hasselt, J.C.A. s.n.* (? holotype L!). (Fig. 1E–G, 4B)

Stereosandra pendula Kraenzl., Bot. Tidsskr. 24: 11 (1901). – TYPE: Thailand, South-Eastern, Ko Chang, *Schmidt, J. s.n.* (not known to exist; see Seidenfaden, 1978: 173).

Herb terrestrial, holomycotrophic, 15–40 cm tall, glabrous. ***Corm*** ellipsoid or ovoid, 1.5–4.4 × 0.6–2.4 cm. ***Stems*** leaf-less, slender to robust, 1–4 mm in diameter; with 2–7 erect and sheathing sterile bracts 1.1–1.8 cm long. ***Inflorescences*** laxly 3- to many-flowered; rachis 3–19 cm long; floral bracts lanceolate, acuminate, 3.5–11.6 × 1.2–4.3 mm, mostly shorter than the ovary. ***Flowers*** resupinate; white or cream with purple markings and purple-tipped sepals, petals and lip; pedicel and ovary distinct from each other, ovary ellipsoid, 3–8.2 mm long, pedicel 1.5–5 mm long; sepals lanceolate, acute to acuminate, 8–10.1 × 1.6–2.2 mm; petals similar, linear-lanceolate, acute to acuminate, 7–9.2 × 2.2–2.6 mm; lip ovate-lanceolate, obtuse to subacuminate, entire to irregularly undulate-crenate, 5–8 × 2.3–3.5 mm, concave; with two ellipsoid wart-like calli at the base; column incurved, 3–4.2 mm long. ***Capsule*** ellipsoid to subspherical, 5–13 × 3–7 mm.

Distribution. Widespread from the eastern Himalayas through the whole of tropical and subtropical Asia to New Guinea and the islands of the southwestern Pacific Ocean (east to Samoa).

Ecology and phenology. The specimens from Myanmar were found in bamboo-rich hill evergreen forest near a stream at an elevation of 180 m. Elsewhere the species is

found in primary evergreen forest from 100 to 1500 m (Seidenfaden & Wood, 1992; Chen et al., 2009; Pedersen, 2014). In the distribution area of the species flowering occurs mostly between March and June but has also been recorded between December and February. At the locality in southern Myanmar both flowering and fruiting plants were seen at the same time.

Material examined. MYANMAR. **Taninthayi Region:** Yebyu Township, 23 Mar 2012, *Saw Lwin, Pan Khet Khet & Zaw Oo Wai TNRO 5* (SING, SING [spirit]). Locally common.

Notes. This is a new generic record for the country. Given its overall distribution (tropical Asia from Thailand and Peninsular Malaysia eastwards to New Guinea; Pridgeon et al., 2005: 528) the occurrence of *Stereosandra* in Myanmar is not surprising. In neighbouring Thailand *Stereosandra javanica* is also found in areas adjacent to the border with Myanmar. Known localities in southern and southwestern Thailand are the provinces of Ranong and Phetchaburi, both bordering Myanmar's Taninthayi Region where our specimen was collected. We suggest that *Stereosandra javanica* may be more widespread in the southern part of Myanmar, but has probably been overlooked because of its inconspicuous appearance.

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A new species of *Zingiber* (Zingiberaceae) from Lao P.D.R.

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ABSTRACT. *Zingiber nitens* M.F.Newman from Lao P.D.R. is described and illustrated.

Keywords. IUCN conservation assessment, Lao P.D.R., new species, *Zingiber*

Introduction

Rhizomes of a wild ginger collected in 2011 by Dr Vichith Lamxay of the National University of Laos and his colleagues were donated to the Royal Botanic Garden Edinburgh for cultivation. As the material they collected was without flowers but had the remains of a terminal inflorescence, the rhizomes were labelled *Alpinia*. When the plant flowered in the living collection at Edinburgh in 2012, it was immediately apparent that this was a new species of *Zingiber*.

Zingiber Mill. is among the larger genera of Zingiberaceae with 144 species (Govaerts et al., 2015) distributed from Sri Lanka and India to southern China, Japan and SE Asia. Schumann (1904) classified the genus into four sections, two of which, *Zingiber* section *Dymczewiczia* (Horan.) Benth. and *Z.* section *Pleuranthesis* Benth., contained species with terminal inflorescences. What Schumann did not observe was that some species in *Zingiber* section *Zingiber* and *Z.* section *Cryptanthium* Horan., such as *Zingiber barbatum* Wall., *Z. gramineum* Noronha ex Blume, and *Z. junceum* Gagnep., could produce inflorescences both radically and terminally (Triboun et al., 2014). Schumann (1904) placed *Zingiber barbatum* in *Zingiber* section *Cryptanthium* Horan. and *Z. gramineum* in *Zingiber* section *Zingiber* (which he called *Zingiber* section *Lampugium* Horan., nom. inval.); Gagnepain (1906) placed *Z. junceum* in *Zingiber* section *Zingiber* (again as *Zingiber* section *Lampugium*).

Now, there are at least eight species of *Zingiber* known to produce terminal inflorescences. They are found from the eastern Himalaya (*Z. capitatum* Roxb. and *Z. clarkei* King ex Baker in India and Sikkim) to Papua New Guinea (*Z. brevifolium* K.Schum.). *Zingiber confine* Miq. is from southern China, *Z. pellitum* and *Z. rufopilosum* Gagnep. are found in Continental SE Asia, *Z. gramineum* is from Java, and *Z. marginatum* Roxb. is a poorly known species of unknown origin.

Theerakulpisut et al. (2012) estimated the phylogeny of 23 species of *Zingiber* using ITS sequences and concluded that *Zingiber* sections *Zingiber*, *Dymczewiczia* and *Pleuranthesis* were individually weakly supported but together formed a well-supported clade sister to a well-supported clade consisting of *Z.* section *Cryptanthium*.

The following description and illustration were made from a full-grown, living plant and the IUCN assessment uses the criteria given in IUCN version 3.1 (2012).

Zingiber nitens M.F.Newman, **sp. nov.**
Belongs to *Zingiber* section *Dymczewiczia* (Horan.) Benth. because the inflorescences are produced terminally on the leafy shoots; similar to *Zingiber capitatum* Roxb. in its slender habit with narrow leaves and terminal inflorescences but differs from it by its glabrous, glossy, dark green bracts which remain green even at fruiting (not green bracts which turn red at fruiting, and are sparsely to densely villose at the margins). – TYPE: Originally a living collection from Lao P.D.R., Bolikhamxai prov., Khamkeut district, Ban Thongpe, Nakai-Nam Theun NPA, Lao-Vietnam Border Protected Area, 18°11′54″ N 104°35′52.9″E, 573 m altitude, primary evergreen forest along river, 1 August 2011, *Lamxay, V., Lanorsavanh, S., Souvannakoummai, K. & Somphone VL2188*, grown on as cultivated material at RBGE acc. no. 20111043A, vouchered and selected as type as *Newman, M.F. 2647* (holotype E, incl. spirit). (Fig 1, 2)

Clump-forming herb 0.65–1 m tall. ***Rhizome*** c. 1 cm in diameter. ***Leafy shoots*** composed of c. 12 leaves, leaf sheaths dark brownish green, especially lower ones, coarsely white villose, hairs pointing in all directions; pseudostem c. 1 cm in diameter; ligule 3–5 mm long with truncate apex, translucent green when young, soon becoming light brown, especially at margin, coarsely white pubescent; swollen petiole light green. Leaf blade narrowly elliptic, 18–25 × 2–3 cm, glabrous and shiny adaxially, sparsely white villose abaxially, especially on midrib, base rounded, apex very long acute. ***Inflorescence*** a terminal, erect thyrse, 9–13 × 1.3–2 cm, cylindrical to fusiform, composed of 9–15 bracts, wrapped round and obscuring rhachis. Bracts subtending to 3–4 flowers, somewhat obovate, c. 35 × 33 mm, glossy, dark green, glabrous, surface with minute oil glands, apex acute, margin translucent. First flower of cincinnus ebracteolate, subsequent flowers with a boat-shaped bracteole, open to base, c. 20 × 6.5 mm, translucent at base, green at apex, glabrous. ***Flower*** exserted from its bract; 4 cm long, calyx 13–16 × c. 4 mm, tubular, inflated, translucent, glabrous, split halfway down one side, apex with 2 short, blunt teeth; floral tube 30–31 mm long, widening slightly towards apex, white at base, pale yellow at apex, lobes pale yellow, glabrous, dorsal corolla lobe triangular, 19–21 × c. 6 mm, margins slightly inrolled, lateral corolla lobes 18–20 × 5–5.5 mm; lateral staminodes triangular, 2.5–6 mm long, almost free from labellum, pale yellow, sometimes with a few red dots; labellum elliptic, c. 18 × 11–12.5 mm, dark maroon with small yellow dots and yellow patch in throat, margins deflexed, apex bifid for 3 mm. ***Stamen*****:** filament 2.5–3 × 3 mm long, yellow; anther c. 11 × 4 mm, connective tissue yellow, thecae dehiscing by longitudinal slits; anther crest 9–10 mm long, wrapped around stigma, curved down into cleft of lip, dark maroon. ***Style*** white, glabrous, stigma white, round, scarcely wider than style, ostiole with ring of straight cilia; epigynous glands 2, subulate, c. 3.6 mm long; ovary cylindrical, c. 3.5 × 2.5 mm, glabrous, incompletely trilocular at base, the three placentas forming a very short axis bearing 10–14 ovules, unilocular above,

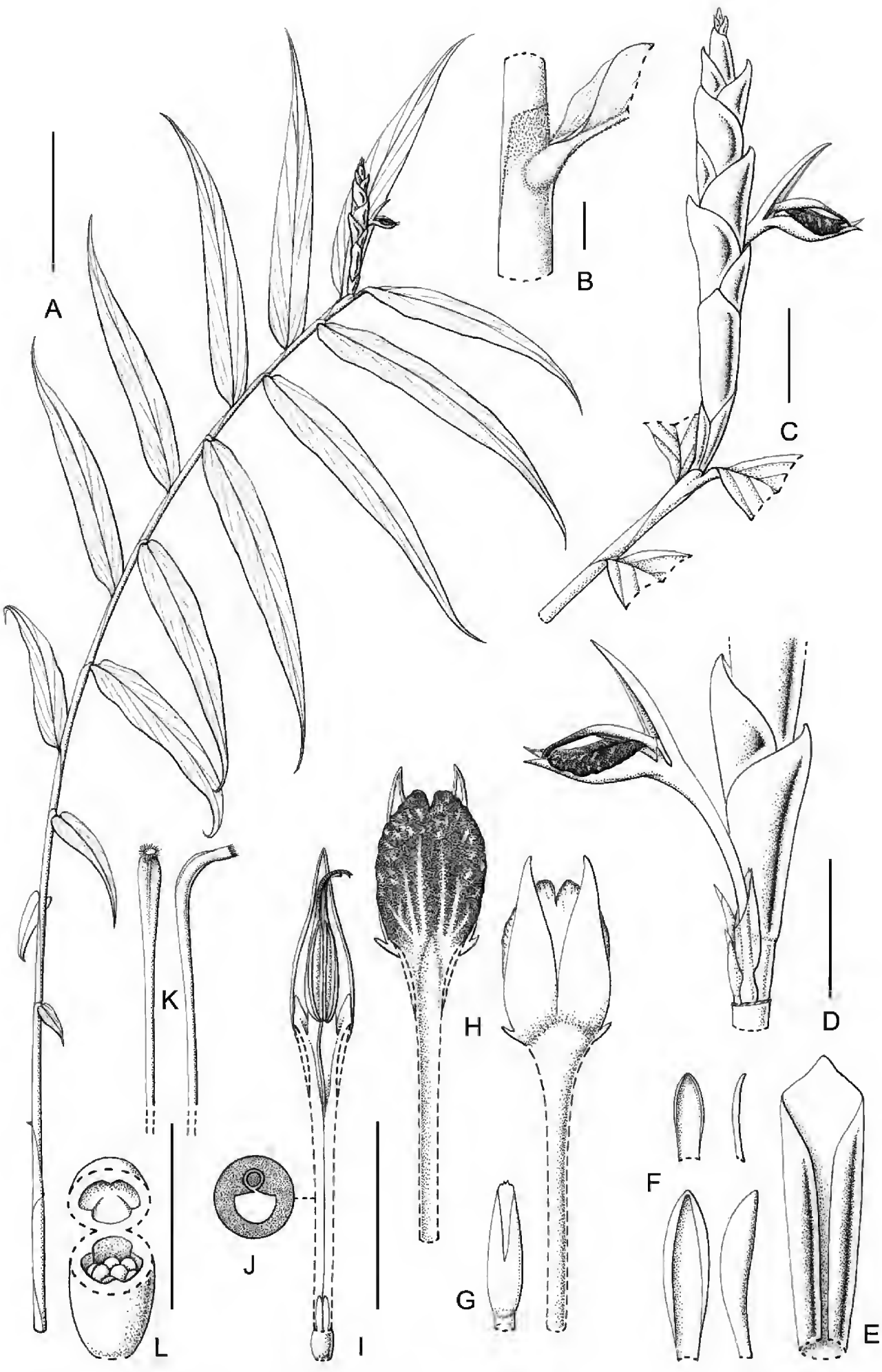

Fig. 1. *Zingiber nitens* M.F.Newman. **A.** Habit. **B.** Ligule. **C.** Inflorescence. **D.** Cincinnus, bract removed. **E.** Bract. **F.** Bracteoles, showing size range. **G.** Calyx. **H.** Floral tube, corolla lobes, labellum and lateral staminodes, abaxial and adaxial views. **I.** Stamen, style, stigma and dorsal corolla lobe. **J.** Detail showing position of style in corolla tube. **K.** Upper style and stigma, adaxial and lateral views. **L.** Ovary (cross-sectioned in apical part). Scale bars: A = 10 cm, B, J–L = 5 mm, C–I = 2 cm. Drawn by Claire Banks from RBGE living accession 20111043A.

Fig. 2. *Zingiber nitens* M.F.Newman, from RBGE living accession 20111043A. (Photo: Mark Newman)

placentas petering out on inside walls not far from base. Infructescence c. 10 cm long, mature fruits unknown.

Phenology. The wild collection, *Lamxay et al. VL2188*, had finished flowering in August but detailed observations on phenology will require further collections.

Distribution & ecology. *Zingiber nitens* is only known from the type locality, where it grows in primary evergreen forest along a river at c. 570 m altitude.

Provisional IUCN conservation assessment. Data Deficient (DD). *Zingiber nitens* is a perennial, terrestrial herb which may be expected to support a certain amount of disturbance. The area in which it was found has a degree of legal protection and there is no evidence that the species is being harvested or otherwise targeted. Until the extent of the wild population is better known, it is impossible to give a more precise assessment.

Etymology. The epithet "nitens", Latin for shining, refers to the shiny bracts of the inflorescence.

Notes. One of the vegetative characters of *Zingiber*, and many other Zingiberoideae, is the presence of an abscission layer at the base of the pseudostem which allows the plant to shed its pseudostems for the duration of the dormant season, whether that is the dry season in the monsoon tropics, or the winter in more northerly areas. *Zingiber nitens* possesses an abscission layer but, in cultivation in Edinburgh, it does not shed all its pseudostems. Instead, the laminae become rather chlorotic looking in the winter but persist. It is not known what happens in wild populations.
All parts of the living plant give off a foetid smell when bruised, and the flowers also smell foetid.

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Taxonomic studies on *Zingiber* (Zingiberaceae) in China I: *Zingiber kerrii* and the synonymy of *Z. menghaiense* and *Z. stipitatum*

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ABSTRACT. A general introduction to *Zingiber* is provided, along with an outline of the materials and methods used in this paper and which are to be used in our subsequent taxonomic studies on *Zingiber* in China. Based on an investigation of the protologues, and on comparisons of both the type specimens and living materials collected from the type localities and their immediate vicinities, *Zingiber stipitatum* S.Q.Tong and *Z. menghaiense* S.Q.Tong are here reduced to synonymy under *Z. kerrii* Craib. A previous lectotypification of *Zingiber kerrii* is discussed and amended. The existence of mixed collections among the isotypes of *Zingiber stipitatum* is highlighted and a proposal to exclude the vegetative parts belonging to *Z. neotruncatum* from the type material is made. A description and a colour plate of *Zingiber kerrii* based on a collection from China are provided.

Keywords. India, Myanmar, synonym, Thailand

Introduction

Zingiber Mill. (Zingiberaceae, Zingibereae) is an economically important genus, best known for the ginger of commerce, *Zingiber officinale* (L.) Roscoe. The genus is widely distributed in tropical to warm-temperate Asia (Wu & Larsen, 2000). According to The Plant List (2013), 244 names have been published in this genus, corresponding approximately to 100–150 species (Theilade, 1999; Wu & Larsen, 2000; Kishor & Leong-Škorničková, 2013). Strongly supported as monophyletic (Kress et al., 2002), this genus is easily recognised among Zingiberaceae either by the flower structure (the horn-shaped anther crest embracing the upper part of the style) or by the vegetative character (the existence of a swollen part of the petiole, widely known as a pulvinus).

The currently accepted infrageneric classification of *Zingiber* recognises four sections, based on the nature and position of the inflorescence: (1) sect. *Zingiber*,

having a spike on an erect and, usually, long peduncle; (2) sect. *Cryptanthium* Horan., characterised by radical inflorescences composed of a spike appearing at ground level with a, usually, short procumbent peduncle; (3) sect. *Pleuranthesis* Benth., with spikes breaking though the leaf sheaths laterally; (4) sect. *Dymczewiczia* Benth., with terminal inflorescences. A recent molecular study based on a single marker and limited material indicates that *Zingiber* sect. *Dymczewiczia* and *Zingiber* sect. *Pleuranthesis* are not well segregated from *Zingiber* sect. *Zingiber* (Theerakulpisut et al., 2012). As more studies involving broader sampling are certainly needed before a new classification can be formally proposed, the traditional sectional treatment is utilised in our current work.

The last comprehensive taxonomic revisions of the genus are more than a century old (Horaninow, 1862; Schumann, 1904), covering only 23 and 55 species respectively. Several regional studies have been made in S & SE Asia in the meantime, e.g. Ridley (1909), Valeton (1918), Loesener (1930), Holttum (1950), Smith (1988a,b), Theilade (1996), Theilade (1999), Sabu (2003), Sabu (2006) and Triboun (2006).

Poor or missing type material, difficulties in the preservation of important floral characters on herbarium specimens through traditional drying methods, as well as variability of certain morphological characters coupled with hybridisation and polyploidy in some genera, make Zingiberaceae taxonomically one of the most challenging plants groups (Larsen, 1980; Theilade, 1999; Škorničková & Sabu, 2005; Leong-Škorničková et al., 2010; Ardiyani et al., 2011). Our current poor understanding, particularly of the larger ginger genera, is further exacerbated by the fact that many previous workers limited their area of study to a single country, rather than working monographically, leading to repeated descriptions of the same taxa. A number of taxonomists have written that the ideal approach to the taxonomic study of gingers is to work with living fertile material or material well-preserved in spirit (Smith, 1988a; Theilade, 1999; Škorničková & Sabu, 2005; Leong-Škorničková et al., 2010). This may involve revisiting and collecting plants from the type localities in order to take precise notes aided by good photo-documentation, and to preserve at least fertile bracts, bracteoles and flowers (or better still the entire inflorescence) in spirit, including having several flowers preserved separately to avoid damage (Burtt & Smith, 1976). A thorough review of the pertinent literature of the species across its phyto-geographical range and good communication between taxonomists working on gingers is also crucial.

The genus *Zingiber* in China

Fifty-three names have been associated with *Zingiber* taxa in China, of which 46 are based on types from China. The most recent taxonomic treatment of *Zingiber* is that of Wu & Larsen (2000) in the *Flora of China*. In this work, 42 species are recognised, with 34 being endemic to China. The genus is mostly restricted to the subtropical zone of China, i.e. south of the Qinling-Huaihe Line (Zhang & Tang, 1991). While the account by Wu & Larsen (2000) serves as a useful overview, the work was based

mostly on the study of imperfectly preserved herbarium material, of which most are not accompanied by spirit material. This resulted in short and often incomplete descriptions lacking basic rhizome and floral characters, and in doubtful synonymies. About a quarter of Chinese *Zingiber* species are known only from the type collections and their identities are poorly understood. There are also a number of presumably well-known species to which a certain name has been applied for an extended period of time, sometimes simultaneously to more than one species, and yet an understanding of what these species really are is not straightforward. These issues can only be unravelled with detailed taxonomic work.

While a thorough revision of *Zingiber* in China is far from complete, accounts for various regional floras in neighbouring countries are in progress. It is therefore useful to disseminate our existing results which include clarifications of the identities of various taxa, the establishment of new synonyms, and the descriptions of new taxa. The present paper, clarifying the identities of two species from Yunnan, *Zingiber menghaiense* S.Q.Tong and *Z. stipitatum* S.Q.Tong, is the first in the series. It, therefore, includes a more detailed introduction to the genus as outlined above, as well as an explanation of the materials and methods applied in our studies, the details of which will not be repeated in subsequent papers.

Material and methods

Our work on a revision of *Zingiber* in China was initiated in 2011. The protologues of all published names along with all other pertinent literature on the genus were collated and reviewed. Searches were made in the relevant herbaria for the original material or type material identified from the protologues. All Chinese specimens of *Zingiber* from China were examined at CDBI, EMA, GXMG, GXMI, HGAS, HITBC (in older literature often referred as YNTBI), IBK, IBSC, KUN, LBG, PE, SYS. Additional material from China and neighbouring countries (particularly Thailand, Laos and Vietnam) was mostly accessed as hi-resolution digital images from the following herbaria: AAU, BK, BKF, BM, C, E, G, HAST, K, KFRI, L, P, SING, TAI, TAIF, US, W, WU. Since 2012 the first author has conducted extensive fieldwork to re-collect fertile material from type localities or their vicinities. Spirit collections, consisting of fertile bracts, bracteoles and single flowers, were made in the field for further study. Extensive photographic documentation was also made following the protocols established by Leong-Škorničková et al. (e.g. 2014a, 2014b). Rhizomes were collected and brought for planting to the greenhouse in South China Botanic Garden for further observation. The terminology in general follows Beentje (2010) and the recent works of Kishor & Leong-Škorničková (2013) and Leong-Škorničková et al. (2014a). While some previous works (e.g. Theilade, 1999; Wu & Larsen, 2000) treated the labellum as a tri-lobed structure composed of a mid-lobe and two side lobes (implying the absence of staminodes in the genus *Zingiber*), this approach has not been supported by any morphological study and is not in accord with our current knowledge of ginger flower structure. In Zingiberaceae, of the six stamens, only the median posterior stamen

of the inner whorl is fertile, while the remaining two are sterile and connate into a labellum. Of the outer whorl, one of the stamens is fully reduced, while the remaining two appear as sterile staminodes (ranging in shape from large and petaloid to small teeth-like structures), flanking the stamen or adnate to the labellum (e.g. Larsen et al., 1998). Petaloid staminodes strongly adnate to labella occur in other Zingiberaceae genera, e.g. *Siliquamomum* or *Siphonochilus*. We therefore agree with the conclusion of various authors (e.g. Ridley, 1899; Holttum, 1950; Smith, 1988a; Larsen et al., 1998) that the side lobes in *Zingiber* are staminodes, which in some species are free to the base and in others are well developed and might be either fully or partially connate to the labellum. In a few species they may be almost fully reduced or even missing. The way we have measured the labellum and lateral staminodes is shown in Fig. 1. The degree of connation is also an important character which should be included in descriptions.

The identities of *Zingiber menghaiense* and *Z. stipitatum*

During initial herbarium work it was noticed that the holotypes of *Zingiber menghaiense* S.Q.Tong and *Z. stipitatum* S.Q.Tong appear to belong to the same taxon (Fig. 2 A–C). At the same time it was also noticed that two of the three existing isotypes of *Zingiber stipitatum* consisted of mixed collections (Fig. 2C). Furthermore, two specimens originally identified as *Zingiber stipitatum* and collected from the vicinity of the type locality of *Z. menghaiense* (*Pei, S.J. 11344* in KUN) were redetermined as *Z. kerrii* Craib by Dr Pramote Triboun in 2002. This prompted us to investigate the complex of these three names in greater detail.

Zingiber menghaiense (Tong, 1987) was described from two collections from Xishuangbanna in south Yunnan, China, *Tong, S.Q. & Li, A.M. 32860* from Menghai Xian and *Tong, S.Q. & Li, A.M. 32902*, from Jinghong city, with the HITBC specimen of the former collection being designated as the holotype (Fig. 2A). When first described, it was inexplicably compared to *Zingiber zerumbet* (L.) Roscoe ex Sm., a very different species with incurved bracts, rather than to other more similar species with appressed bracts.

In the same article, Tong (1987) described *Zingiber stipitatum* based on a single collection, *Tong, S.Q. & Liao, C.J. 24836* from Ruili Shi, Dehong Zhou, in the southwest of Yunnan (holotype HITBC48857, Fig. 2B). In the protologue it was compared to *Zingiber menghaiense*. Both species have a narrow, lanceolate, glabrous lamina of similar size and shape, a long erect peduncle, an oblong or narrowly ovoid spike, pale green bracts with a purple red margin, a whitish labellum, and lateral staminodes with red patches on both sides of the bases. *Zingiber stipitatum* was said to differ by the following characters: (1) the ligules 6 mm long, emarginate (versus 6 mm long, bilobed in *Z. menghaiense*); (2) the labellum orbicular with emarginate apex and petiolate [meaning it has an attenuate base or is clawed] (versus labellum narrowly obovate, apex bifid in *Z. menghaiense*); (3) the entire lateral staminodes which are shortly acuminate at the apices (versus bifid at apices in *Z. menghaiense*).

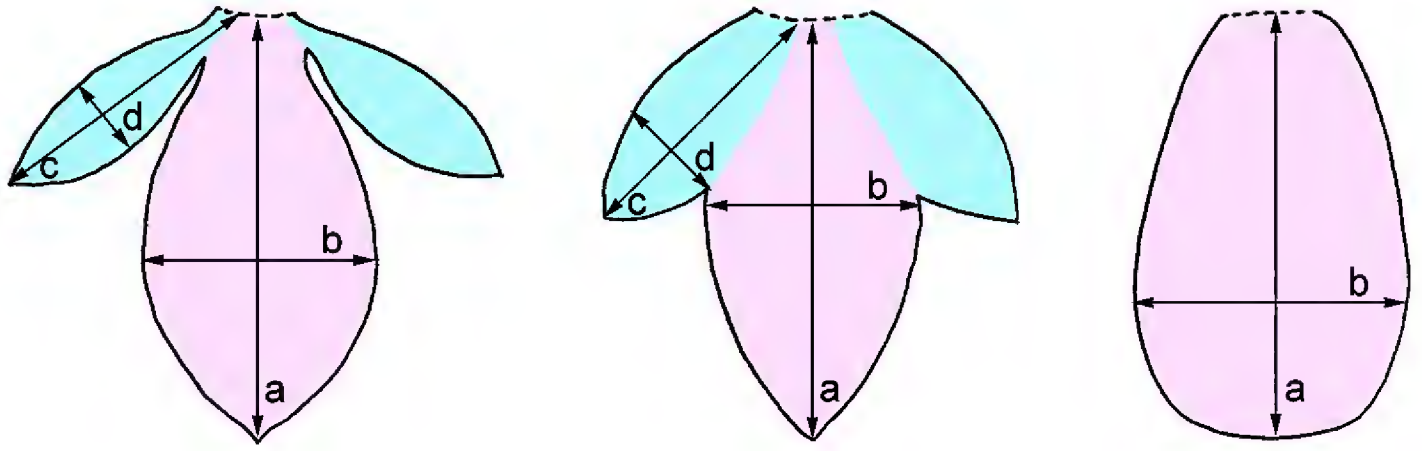

Fig. 1. Schematic outlines of selected types of labellum (pink) and lateral staminodes (blue) occurring in the genus *Zingiber*. From left to right, lateral staminodes nearly free from labellum, lateral staminodes connate to labellum by basal ⅔, lateral staminodes absent. (a) length of labellum, (b) width of labellum, (c) length of lateral staminodes, (d) width of lateral staminodes.

A comparison of the holotypes of the two species reveals that they are quite similar to each other. Also, the holotype of *Zingiber stipitatum* does not match the protologue as the ligules are c. 3 mm long and clearly 2-lobed. Though shorter, the ligules of *Zingiber stipitatum* are also very similar to those of *Z. menghaiense* in their nearly coriaceous texture, being slightly pubescent, with a prominent raised vein on the base and the membranous margin. As pointed out by Triboun (2006), the length of ligules in *Zingiber* varies according to the position of leaves on the pseudostem and those in the middle part of the shoot are usually longer than the others. Three isotypes of *Zingiber stipitatum* were located at HITBC and KUN herbaria (HITBC49032, KUN0833208 and KUN0833209). Further examination of these sheets revealed that while the isotype at HITBC is of the same taxon as the holotype, the plant parts mounted on the other two isotypes at KUN (KUN0833208, KUN0833209 (Fig. 2C)) belong to two different species. The ligules on the shoots are emarginate and c. 6 mm long, consistent with the description and the painting in the protologue, while they conflict with the protologue and the holotype in the lower lamina surface, sheaths and ligules being densely villous (they are glabrous in the protologue and holotype). These two shoots are easy to recognise as *Zingiber neotruncatum* T.L.Wu, K.Larsen & Turland, which also occurs in Ruili as mentioned in its protologue (Tong, 1987), while the inflorescences are certainly of *Z. stipitatum* (the inflorescence of *Z. neotruncatum* has shorter peduncles and is more or less bent and without a dark brown tinge on the tips of the bracts). As confirmed by the first author in the field, *Zingiber neotruncatum* is quite common at the type locality of *Z. stipitatum*. It appears that the description of *Zingiber stipitatum* in the protologue is based on these two different species. The character of the ligules being emarginate, the only vegetative character used by Tong (1987) to distinguish *Zingiber stipitatum* from *Z. menghaiense*, is derived from the leafy shoots of *Z. neotruncatum* present in the two isotypes. After their exclusion, all the remaining original materials show no critical differences to the type specimens of *Zingiber menghaiense*. Further observation of floral characters was made through

Fig. 2. *Zingiber kerrii* Craib. **A.** Holotype of *Z. menghaiense* S.Q.Tong (*Tong, S.Q. & Li, A.M. 32860*, HITBC Acc. No. 048849). **B.** Holotype of *Z. stipitatum* S.Q.Tong (*Tong, S.Q. & Liao, C.J. 24836*, HITBC Acc. No. 049032). **C.** One of the two mixed isotypes of *Z. stipitatum* S.Q.Tong; the inflorescence belongs to *Z. stipitatum*, the leafy shoot belongs to *Z. neotruncatum* (*Tong, S.Q. & C. J. Liao, C.J. 24836*, KUN Acc. No. 0833209; barcode 1219333). **D.** Lectotype of *Zingiber kerrii* Craib (*Kerr, A.F.G. 1290*; barcode K000255235); reproduced with the kind permission of the Director and the Board of Trustees, Royal Botanic Gardens, Kew.

the field work of the first author in 2012 and 2013. More than ten individuals were found at the type locality of *Zingiber menghaiense*, with the flowers examined having entire lateral staminodes (as opposed to staminodes with bifid apices as stated in the protologue) but all other characters matched the protologue and the type specimens well. According to our observation of several other *Zingiber* species (i.e. *Z. longyangjiang* Z.Y.Zhu), the phenomenon of lateral staminodes being bifid to various degrees occurs occasionally in populations with otherwise entire staminodes, and is therefore not to be considered a reliable character to distinguish two species. The shape of the labellum also varies within and between populations and we have observed varying degrees of narrowing at the bases and notches at the apices which covers the shapes of labella as depicted in the line drawings of *Zingiber stipitatum* and *Z. menghaiense* published in the protologues. At the type locality of *Zingiber stipitatum*, which is 360 km away (as the crow flies) from the type locality of *Z. menghaiense*, only *Z. neotruncatum* was found. However, plants matching the description of *Zingiber stipitatum* were found within 20 km of the type locality and these are identical to those from the type locality of *Z. menghaiense*. It is, therefore, concluded here that *Zingiber stipitatum* is the same taxon as *Z. menghaiense*.

The identity of *Zingiber kerrii* Craib

Zingiber kerrii Craib was described in 1912 from a collection from Northern Thailand (Chiang Mai *Kerr 1290,* Fig. 2D) (Craib, 1912). It was included in the revisions of *Zingiber* in Thailand by Theilade (1999) and Triboun (2006) and both works included photos of the inflorescence and flower. The species was also reported to occur in Shan state in Myanmar (Kress et al., 2003) and in Manipur state in India (Thongam et al., 2013). Compared to the Thai collections (Theilade, 1999; Triboun, 2006), the Indian collection is slightly different by having the labellum and lateral staminodes creamy white throughout. Our collection of *Zingiber menghaiense*, approximately 400 km away from the type locality of *Z. kerrii,* shows more resemblance to *Z. kerrii* than the Indian record, especially in the coloration of the labellum and lateral staminodes. Even though the laminas are only c. 2.5 cm wide in the type material of *Zingiber kerrii*, and described as 2.3 cm wide by Triboun (2006), they can reach up to 5 cm wide in some other specimens in Thailand, similar to the measurements reported from India (Thongam et al., 2013). Chinese collections consistently have laminas 3.5–4 cm wide. In conclusion, we agree with Triboun that *Zingiber menghaiense* (and also *Z. stipitatum* as noted above) is the same taxon as *Z. kerrii*. Therefore, *Zingiber menghaiense* and *Z. stipitatum* are reduced to synonymy under *Z. kerrii*. Colour plates, including a flower dissection of *Z. kerrii* from Yunnan, are provided (Fig. 3, Fig. 4).

Theilade (1999), in her revision, indicated the presence of syntypes of *Kerr 1290* at BK, BM, E and K and proposed the lectotypification of *Zingiber kerrii* with a specimen deposited at K. However, the Kew herbarium has two specimens of *Kerr 1290*, both of which contain both a leafy shoot and an inflorescence, and as there is no indication that these two specimens are part of a single preparation, a further

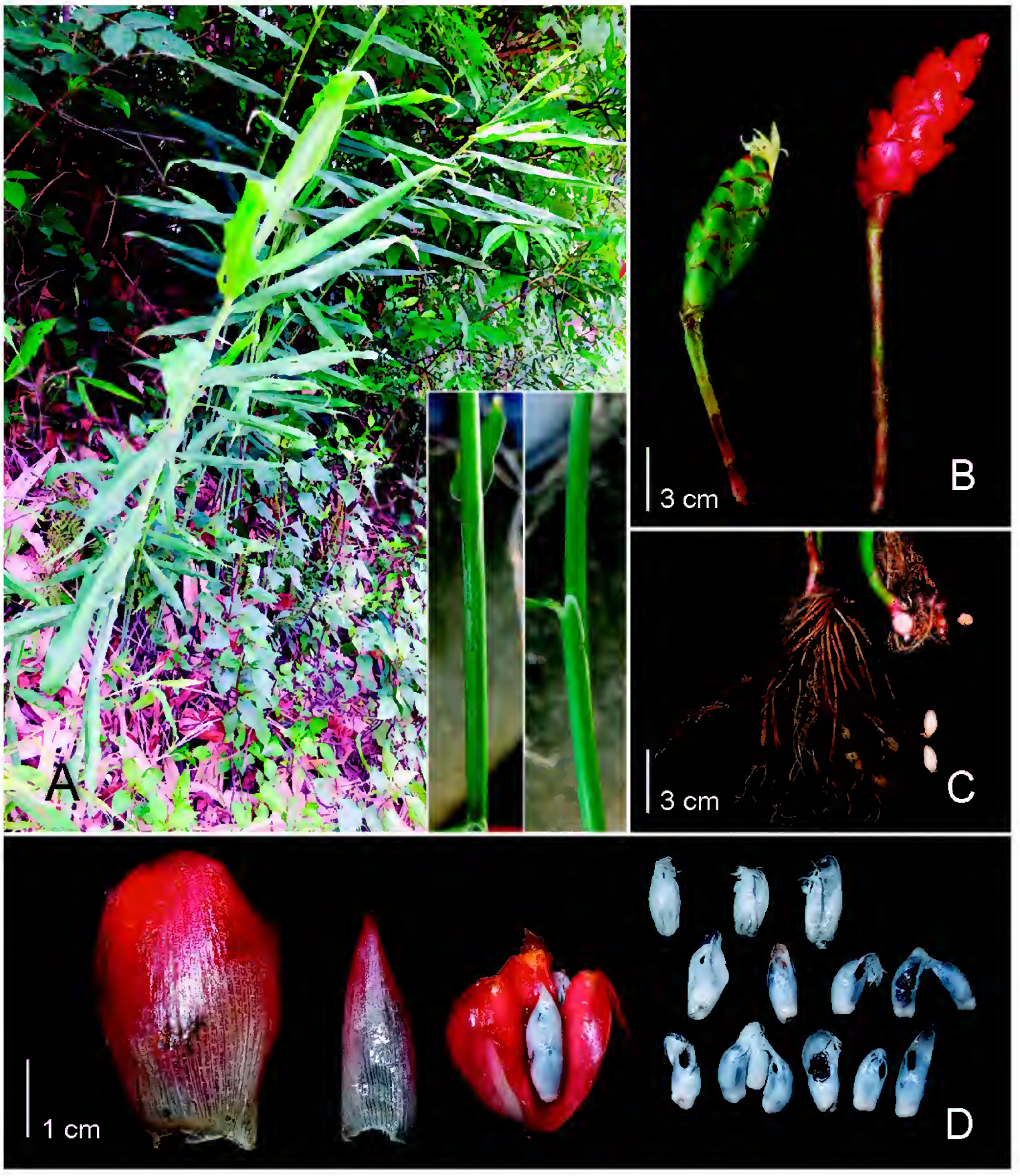

Fig. 3. *Zingiber kerrii* Craib. **A.** Young shoots (inset: leaf sheath and ligule). **B.** Inflorescences (left at anthesis, right in fruit). **C.** Old rhizome with root tubers and section of young rhizome and root tubers. **D.** From left: Bract, bracteole, mature capsule (dehisced) and seeds enclosed in arils. From *Bai, L. 13080301* and *Bai, L. 12091402*, from the type locality of *Zingiber menghaiense*. (Photos: L. Bai)

second step lectotypification is needed. In conformity with the ICN (Arts. 8.3, 9.17) we designate here one of these two specimens, which also contains a flower dissection (barcode K000255235), as the lectotype.

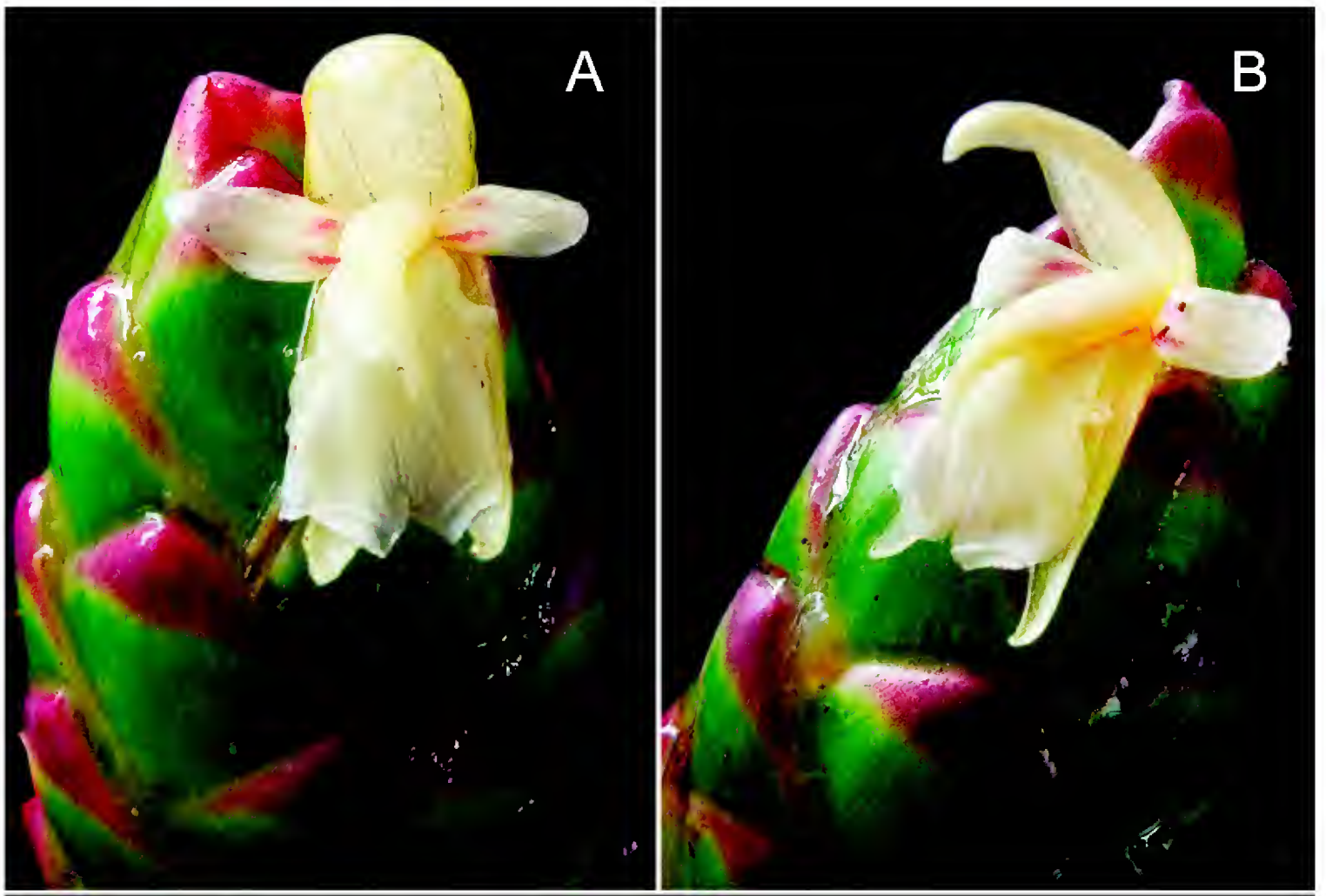

Fig. 4. *Zingiber kerrii* Craib. **A.** Flower (front view). **B.** Flower (semi-side view). **C.** Flower dissection (from left to right: bract, bracteole, single flower in side view, dorsal corolla lobe, two lateral corolla lobes, labellum with lateral staminodes partially basally connate, stamen with upper part of style in the groove between two anther thecae. From the type locality of *Zingiber menghaiense, Bai, L. 13080301*. (Photos: L. Bai)

Zingiber kerrii Craib, Bull. Misc. Inform. Kew. 10: 403 (1912); Loesener in Nat. Pflanzenfam.15a: 588 (1930). – TYPE: Thailand, Chiang Mai, Doi Sootep, in evergreen jungle, 660 m., 24 July 1910, *Kerr, A.F.G. 1290* (lectotype K! [K000255235],

designated here; isolectotypes BK n.v., BM! [BM000858181], E! [E00097850], K! [K000255234], P! [P00450941]).

Zingiber menghaiense S.Q.Tong, Acta Phytotax. Sin. 25 (2): 145–146, pl. 1, f. 2. (1987); S.Q.Tong in Fl. Yunnan 8: 533 (1997); T.L.Wu & K.Larsen in Fl. China. 24: 326 (2000), **synon. nov.** – TYPE: China, Yunnan Province, Xishuangbanna Daizu Zizhizhou, Menghai Xian, Menghai Zhen, under the forest on the roadside, 1200 m, 2 Jul 1982, *Tong, S.Q. & Li, A.M. 32860* (holotype HITBC! [catalogue number 048849]; isotype KUN! [catalogue number 0833203]).

Zingiber stipitatum S.Q.Tong, Acta Phytotax. Sin. 25 (2): 146–147, pl. 1, f. 3. (1987); S.Q.Tong, in Fl. Yunnan 8: 532 (1997); T.L.Wu & K.Larsen in Fl. China. 24: 326 (2000), **synon. nov.** – TYPE: China, Yunnan Province, Dehong Daizu Jingpozu Zizhizhou, Ruili Shi, Mengxiu Xiang, on the way from Mengxiu Cun to Daoba Zhai, 1200 m, 25 Jul 1983, *Tong, S.Q. & Liao, C.J. 24836* (holotype HITBC! [catalogue number 48857]; isotypes HITBC! [catalogue number 49032], KUN! ([catalogue number 0833208], pro parte, excluding the leafy shoot), KUN! ([catalogue number 0833209], pro parte, excluding the leafy shoot).

Perennial rhizomatous herb 1.2–1.6(–2.5) m tall, glaucous throughout (although not obviously so when old). ***Rhizomes*** fleshy, densely branched, 10–20 mm in diameter, light brown externally, internally purple-pink when young, orange-yellow when old; *root tubers* ovate to fusiform, c. 2 × 1 cm, externally whitish brown, internally pale grey. ***Leafy shoots*** to 15 in a tuft, with up to 44 leaves when flowering, less than from the base leafless; *leaf sheaths* longitudinally striate, tubular at base; *ligule* 1–4(–6) mm long, bilobed, apices obtuse triangular, base green, turning blackish and coriaceous when old, with obvious raised veins, upper part hyaline, membranaceous, densely pubescent, glabrescent when old; *petiole* to 9 mm long, consisting of pulvinus only, sparsely pubescent; *lamina* linear to narrowly-ovate, 15–34 × 1.8–3(–4.5) cm, glaucous and glabrous on both side, base obtuse to attenuate, apex acuminate. ***Inflorescences*** 1–3, radical; *peduncles*12–20 cm long, erect, with pink scales on the base; *spikes* fusiform or cylindrical, apices acute, 10–15 × 5–6 cm, *fertile bracts* each subtending one flower, broadly obovate or broadly spathulate, slightly longer than the floral tube, green with purple red apices, 3–4.5 × 2–4 cm, apices rounded, whole spikes turning scarlet when fruiting; *bracteoles* narrowly ovate, apex acute, c. 30 × 6 mm, semi-translucent, sparsely pubescent externally, glabrous internally. ***Flowers*** 5–6 cm long; *calyx* tubular, membranaceous, c. 1 cm long, unilaterally split to 4 mm, apex slightly dentate or nearly truncate, sparsely pubescent outside, glabrous inside, semi-translucent; *floral tube* creamy white, c. 3 cm long; *dorsal corolla lobe* narrowly ovate, c. 18 × 9 mm, cream-white, concave, glabrous, apex mucronate; *lateral corolla lobes* narrowly ovate, c. 18 × 7 mm, creamy, glabrous; *labellum* obovate with conspicuous attenuate base, c. 26 × 12 mm, creamy, with purple red patch on the base, apex emarginate or bifid, margin revolute; *lateral staminodes* narrowly obovate, narrowly oblong or narrowly triangular, c. 18 × 4 mm, basal ⅕, or even less, connate to labellum,

creamy with two purple-red patches on the base, apex rounded to attenuate. ***Stamen*** c. 17 mm long; *filament* reduced to less than 1 mm, *anther* c. 11 mm long, connective tissue pale yellow, *anther thecae* 11 mm long, dehiscing throughout entire length, pollen pale yellow, *anther crest* c. 6 mm long, pale yellow. ***Style*** filiform, white, glabrous; *stigma* funnel form, white, ostiole ciliate. ***Ovary*** cylindrical, pale yellow, trilocular, central placentation, with c. 20 ovules in each locule, c. 5 × 3 mm, densely pubescent; *epigynous glands* two, pale yellow, c. 4 mm long, 0.3 mm in diameter, apex blunt. ***Fruits*** obovoid to nearly sphaerical or bluntly trigonous capsules, c. 22 × 18 mm, sparsely villous, greenish-cream with red tinge externally, red internally; *seeds* obovoid, c. 5 × 4 mm, dark brown, glossy, with obvious white hilum on the base; aril white, sac-like, apex with irregular margin, covering most of the seed.
Distribution. Zingiber kerrii is distributed in India, China, Myanmar and Thailand. (Fig. 5). According to our photographic records, the species is also present in Laos (Leong-Škorničková, unpublished).

Ecology. In China, *Zingiber kerrii* occurs in grassy areas on the forest edge, in bamboo forest and evergreen broad-leaf forest at altitudes of 700–1300 m.

Provisional IUCN conservation assessment. Least Concern (LC). This species has a large extent of occurrence (around 230,000 km2) and is known from more than 10 localities of which some are protected. We, therefore, provisionally propose this species to be Least Concern (LC) according to the latest IUCN criteria (2012).

Additional specimens examined. CHINA: **Yunnan:** Dehong Daizu & Jingpozu Zizhizhou, Lianghe Xian, Mengyang Zhen, Dangliang Cun, 26 Sep 2012, *Bai, L. 12092603* (IBSC); *ibidem,* 17 Aug 2013, *Bai, L. 13081701* (IBSC); Ruili Shi, Mengliu Xiang, Mangling Cun, Moli, 21 Sep 2012, *Bai, L. 12092103* (IBSC); Xishuangbanna Daizu Zizhizhou, Jinghong Shi, Jinuo Xiang, Longpa cun, *Zhou, S.S. 3212* (HITBC); Menghai Xian, Menghai Zhen, Manduan Cun, 14 Sep 2012, *Bai, L. 12091402* (IBSC); ibidem, 3 Aug 2013, *Bai, L. 13080301* (IBSC); Mengla Xian, on the road from Mengxing Xiang to Manla Zhen, 1100 m, 21 Oct 2005, *Zhou, S.S. 3069* (HITBC); Mengla Xian, Yiwu Xiang, 700 m, 9 Nov 1959, *Pei, S.J. 59-11344* (two sheets in KUN); Zhenyue Xian (Mengla Xian), 1200 m, Nov 1936, *Wang, C.W. 80620* (PE).
THAILAND: **Chiang Mai:** Chom Thong District, Vachi Ratharn Waterfall on Doi Intanon, 650–800 m, 15 Sep 1995, *Larsen, K. et al.. 46498* (AAU); Doi Sutep, 1250 m, 30 Jul 1968, *Sorensen, T. et al. 3948* (AAU); Doi Sutep, 1120 m, in 1958, *Sorensen,T. et al.* 4539 (AAU); Inthanon National Park, 850 m, 22 Jul 1988, *Phengklai, C. et al. 6757* (BKF); Mae Sa, Rock Tower Mountain, 18 Sep 1995, *Larsen, K. et al. 46636,* (AAU); Pong Pho 12 km of Doi Chieng Dao, 1200 m, 30 Jul 1968, *K. Larsen et al. 2874* (E, AAU, BKF); **Phitsanulok:** Chat Trakan District, Phu Soi Dao National Park, 20 Jul 2006, *Poulsen, A.D. & Suksathan, P. 2401* (E); **Chaiyaphum:** Thep Sathit District, 29 Aug 2001, *Pooma, R. et al. 2940* (BKF).

Notes. Zingiber kerrii is similar to *Z. laoticum* Gagnep. in the entire plant being glaucous externally (particularly prominent in young shoots, becoming inconspicuous when older), bracts pale green with pink-red margins and rhizomes and pseudostems purple-red internally. *Zingiber laoticum* differs from *Z. kerrii* by the broader labellum which

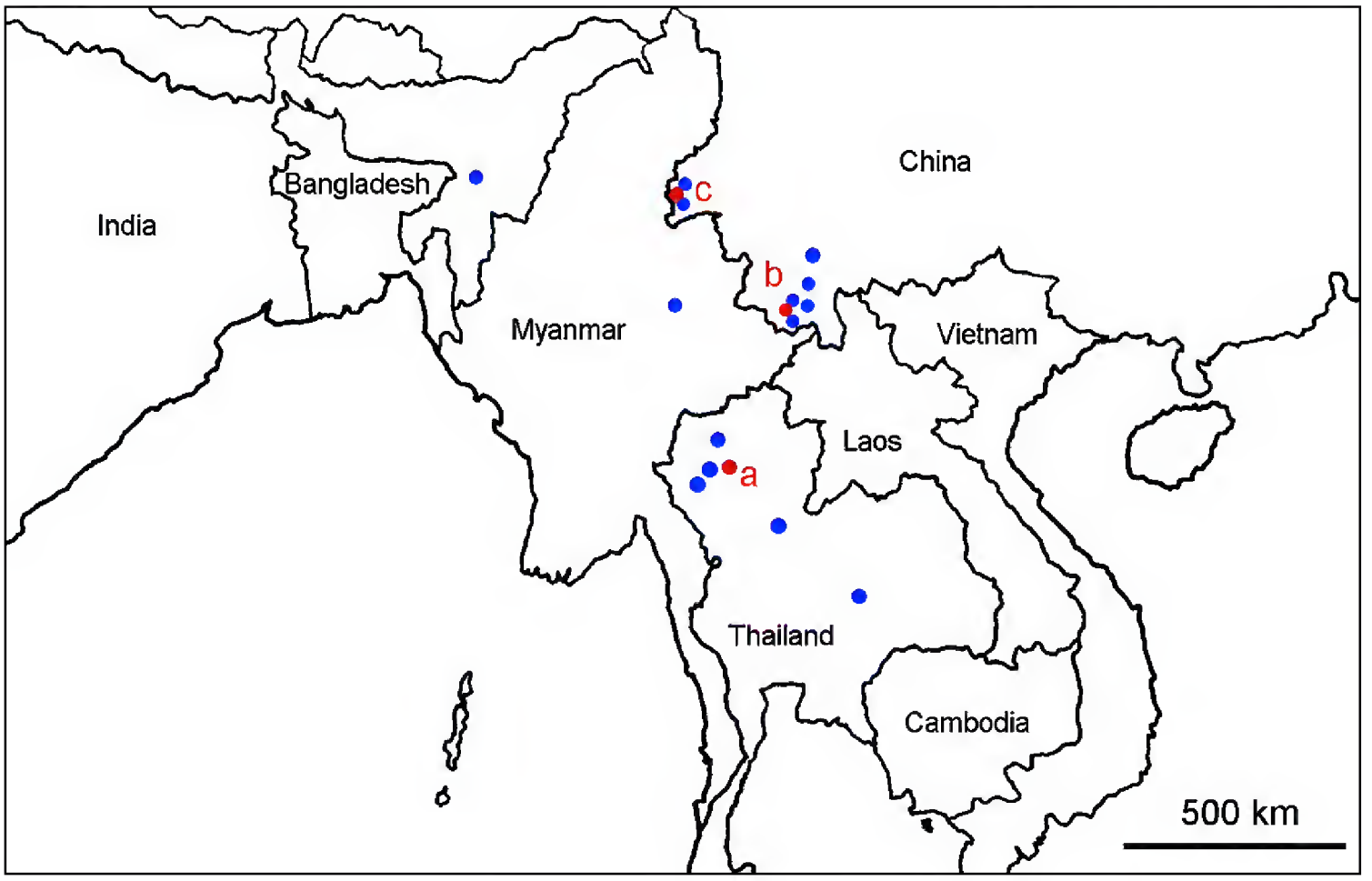

Fig. 5. Distribution of *Zingiber kerrii* Craib, based on herbarium material and literature records. The type localities of the three names are indicated in red. (a) *Zingiber kerrii* Craib, (b) *Z. menghaiense* S.Q.Tong, (c) *Z. stipitatum* S.Q.Tong.

is richly mottled in dark purple-brown, and longer (c. 15 mm), entire, membranous ligules.

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Pennilabium labanyaeanum (Orchidaceae), a new species from Meghalaya, Northeast India

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ABSTRACT. A new orchid species, *Pennilabium labanyaeanum* C.Deori, N.Odyuo & A.A.Mao, is described and illustrated from Meghalaya, India. A key to the species of *Pennilabium* in India is provided.

Keywords. India, Meghalaya, new species, Orchidaceae, *Pennilabium*

Introduction

The genus *Pennilabium* J.J.Sm. (Orchidaceae) (*penni-* = feathered, *-labium* = lip) is a genus of 16 species of epiphytes in the tribe Vandeae, subtribe Aeridinae. It is distributed from northeastern India and southern China to the Philippines and Sulawesi, with centres of diversity in Peninsular Malaysia and Borneo (Seidenfaden, 1988; O'Byrne, 2000; O'Byrne et al., 2009; Schuiteman, 2013; Govaerts, 2014; Pridgeon et al., 2014). The plants are small twig or branch epiphytes, the flowers are ephemeral and open in succession, and the lip is spurred with small or large and often fimbriate or marginally toothed side lobes, often with a fleshy mid-lobe. The column lacks a foot and contains two pollinia on a long strap-like stipe; the rostellum is normally beaked (Pridgeon et al., 2014).

In India two *Pennilabium* species are known, both of which are confined to the Northeast: namely, *P. proboscidcum* A.S.Rao & J.Joseph from Meghalaya and *P. struthio* Carr from Arunachal Pradesh. During a botanical tour to Laitkyrhong, 5 km from Smith, East Khasi Hills District, Meghalaya, in July 2014, the first two authors discovered a small *Pennilabium* with pure white flowers. After critical study of specimens and the literature (Holttum, 1957; Rao & Joseph, 1969; Garay, 1972; Comber, 1990; Rao, 1996), and comparison to the protologue and spirit material of the type specimen of the morphologically most similar taxon, *Pennilabium naja* P.O'Byrne (O'Byrne, 2000), this plant was found to be morphologically different from all other species. Our plant from Meghalaya is therefore described as the new species *Pennilabium labanyaeanum* C.Deori, N.Odyuo & A.A.Mao. Schuiteman (in Pridgeon et al., 2014: 230) points out that 'the generic delimitation of the genera closely allied to *Pteroceras*, including *Pennilabium*, needs further study, and *Pennilabium* is only tentatively accepted here'. Kocyan & Chase (in Pridgeon et al., 2014: 230) pointed

that only two *Pennilabium* species were sampled in their molecular study, and said 'it would appear that some changes to the taxonomy of this clade will be required once greater sampling of the species has been accomplished.'

Pennilabium labanyaeanum C.Deori, N.Odyuo & A.A.Mao, **sp.nov**.
Pennilabium labanyaeanum is similar to *P. naja* in having reduced sidelobes but differs in the flower being only half open; the sepals and petals pure white; the sepals obtuse, keeled dorsally and 5-veined; the lip base forming a narrow hollow channel with minute hairs; the lip epichile unlobed with erose margins, without a prominent raised callus but with an area of yellow powdery substance widening towards the lip apex; and the short white spur (see Table 1, Fig. 2). – TYPE: India, Meghalaya, Laitkyrhong, 5 km from Smith, East Khasi Hills, 1753 m, 25°26′53.2″N 91°52′48.6″E, 23 July 2014, *Deori, C. & Odyuo, N. 131601* (holotype CAL [as *131601A*]; isotypes ASSAM [as *131601B-E*]). (Fig.1, 2)

Small monopodial epiphytic herbs, 3–5 cm tall, glabrous. ***Roots*** 5–30 cm long, 2–4 mm in diameter, several from base of stem below leaves, white with green tips. ***Stems*** 1–2.5 × 0.3–0.5 cm, very short, compressed with a few leaves close together. ***Leaves*** 1.5–6 × 0.5–1.5 cm, distichous, elliptic or broadly lanceolate, more or less fleshy, often twisted at the base, leathery, green, basally sheathing, unequally bilobed at apex, apices subacute to obtuse. ***Inflorescence*** 2.5–6 cm long, unbranched, lateral, emerging through sheath opposite leaf, erect or parallel to the leaves, producing 2–3 flowers in succession; peduncle 2–3.5 cm long, slender, cylindrical, base covered with two sheaths; sheathing sterile bracts below rachis two, c. 2 × 4.5 mm, somewhat rectangular in shape, lemon green; rachis 5–10 mm long, complanate-cylindrical, ridged with one to three distichously arranged flowers opening in succession; floral bract 2–2.5 × c. 1.5 mm, persistent, ovate-triangular, obtuse, lemon green. ***Flowers*** 12–14 mm long from the tip of the dorsal sepal to the tip of the spur, 8–10 mm broad, ephemeral, half open, formed in succession, sepals and petals pure white with yellow markings on the epichile of the lip. ***Pedicel with ovary*** 1–2.6 cm long, lemon green, 3-ridged. ***Sepals*** oblong with narrow bases, obtuse, 5-veined, on the dorsal side with keels which apically project as small apicules; dorsal sepal 7–10 × 3–4 mm; lateral sepals 8–9.5 × 3.5–4 mm. ***Petals*** 7.5–9 × 2.5–3 mm (base narrow), oblong with narrow base, obtuse with 3 main veins, lateral veins branched. ***Lip*** spurred, 11.5–12.5 mm long (including the spur), 4–5 mm wide at the centre and 3 mm at the apex, unlobed, suborbicular or ovate, lateral margins of lip erose; lip base with a narrow hollow channel with minute hairs within; epichile fleshy, solid, thick (1 mm in diameter), with an area of yellow powdery substance widening towards the lip apex. ***Spur*** 5–7 mm long from junction of lip base and the column, white, slender, tip rounded, 1.5 mm wide, aseptate and ecallose; longitudinal section of the spur shows sparse minute hair-like structure or raised edges at mouth towards the centre. ***Column*** 2–2.5 × c. 2 mm, without a foot, rounded, without stelidia; stigmatic cavity very broadly ovate; rostellum not seen. ***Anther*** 1–1.5 × 1.5–2 mm, operculum c. 0.2 × 0.5 mm, truncate, entire. ***Pollinia*** two,

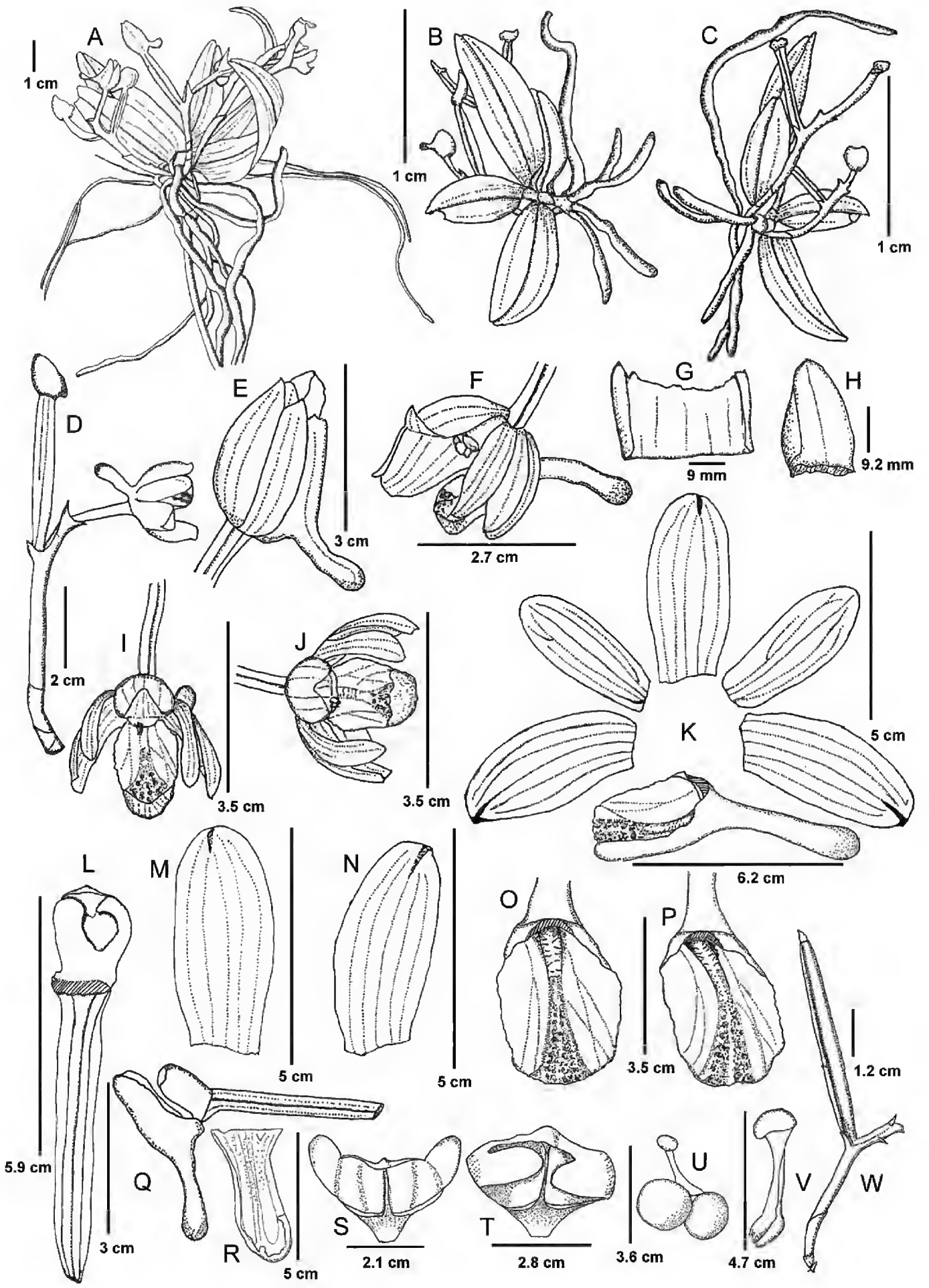
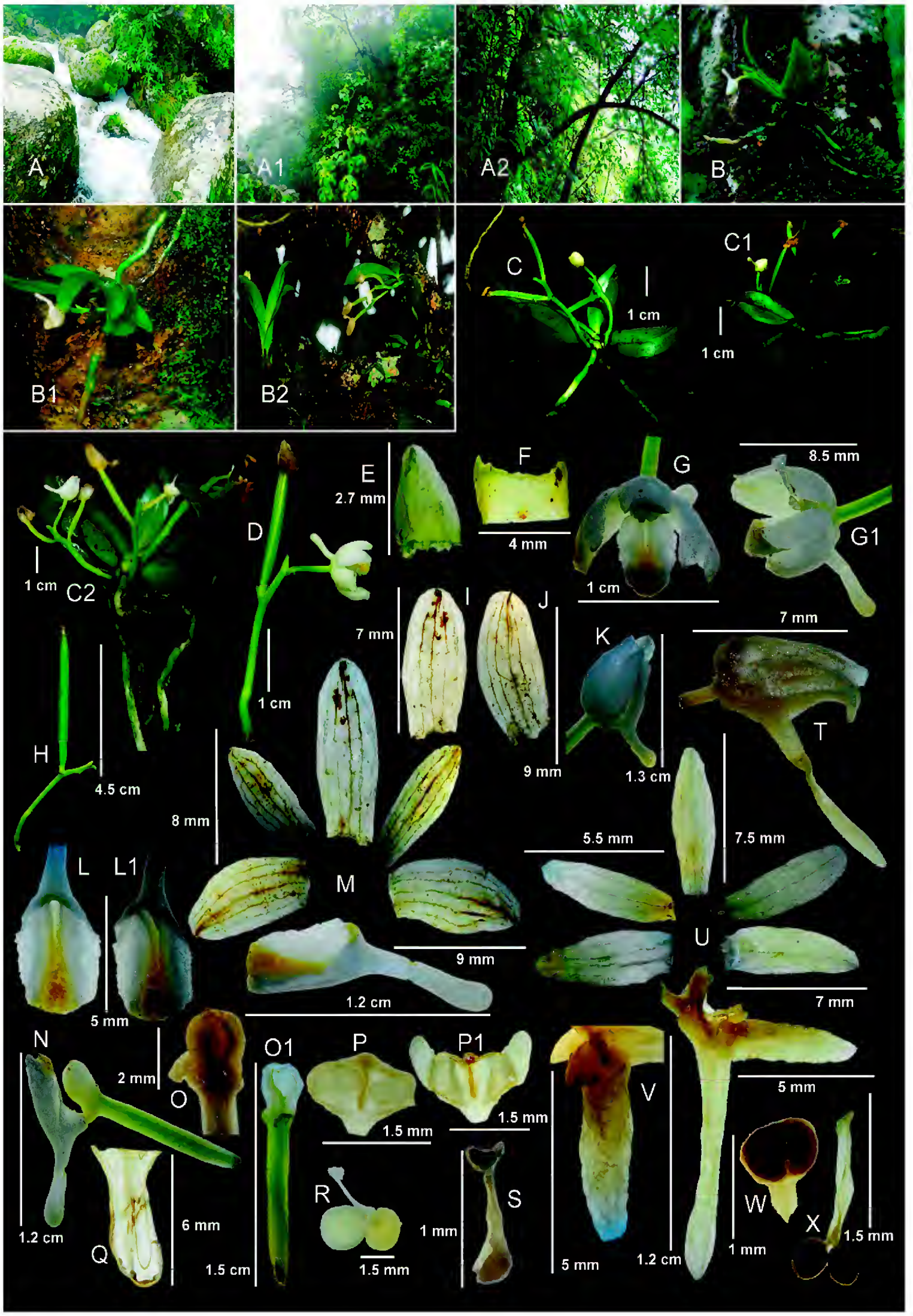


Fig. 1. *Pennilabium labanyaeanum* C.Deori, N.Odyuo & A.A.Mao. **A–C.** Habit. **D.** Inflorescence. **E.** Flower bud. **F.** Flower (side view). **G.** Peduncle sheath. **H.** Floral bract. **I–J.** Flower (front & side views). **K.** Floral perigon with spurred lip. **L.** Column with pedicel and ovary. **M.** Dorsal sepal (dorsal view). **N.** Lateral sepal (dorsal view). **O.** Lip (front view). **P.** Lip front view (highlighting the narrow hollow channel with minute hairs at the base). **Q.** Spurred lip (side view) with column, pedicel and ovary. **R.** Longitudinal section of spur. **S–T.** Anther (front views). **U.** Pollinia with stipe. **V.** Stipe. **W.** Fruit. (Drawn by: C. Deori)


A
A1
A2
B
B1
B2
C
1 cm
C1
1 cm
1 cm
C2
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E
2.7 mm
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G
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G1
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I
J
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K
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T
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R
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1 mm
S
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V
1.2 cm
5 mm
W
X
1 mm
1.5 mm

c. 1 mm long (including stipe), 0.5–0.7 mm in diameter, globose, entire; stipe 0.7–1 mm long, widening near the attachment of the pollinia, with a small disc. ***Fruits*** erect, slender, 3–5.2 cm long which is more than twice the flower length, 3-ridged.

Distribution and habitat. Pennilabium labanyaeanum was found growing epiphytically on moss-covered branches of trees. The species was flourishing in a steep subtropical hill forest along a stream side at 1753 m altitude near Laitkyrhong, 5 km from Smith, East Khasi Hills District, Meghalaya, India. It was associated with other orchid species in the genera *Dendrobium* Sw. and *Eria* Lindl. s.l., amongst others.

Phenology. Flowering and fruiting: July–August.

Etymology. The specific epithet is given in honour of the first author's mother (L. Labanya Deori, 1945–1993).

Provisional IUCN conservation assessment. Data Deficient (DD). *Pennilabium labanyaeanum* is so far known only from a single locality in the East Khasi Hills District in Meghalaya. According to O'Byrne (2009), all species in the genus *Pennilabium* are uncommon or rare and occur in small colonies that can be widely separated from each other. If this is also the case for *Pennilabium labanyaeanum*, the new species might be more widespread in Meghalaya than is currently known and further exploration is necessary before a threat status can be given.

Notes. Pennilabium labanyaeanum is distinct in the genus due to its unlobed suborbicular lip. The new species is similar to *Pennilabium naja* from Sulawesi but differs as discussed above (see also Table 1, Fig. 2). As already pointed out by Garay (1972) there are two types of lip structure in *Pennilabium*: 1. Lateral lobes well developed and midlobe reduced to a small fleshy lobe; 2. Lateral lobes much reduced, possibly represented only by small auricle-like lobes, and midlobe very prominent,

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Fig. 2. A–S. *Pennilabium labanyaeanum* C.Deori, N.Odyuo & A.A.Mao. **A–A2.** View of the type locality. **B–B2.** *Pennilabium labanyaeanum* in the wild. **C–C2.** Habit. **D.** Inflorescence. **E.** Floral bract. **F.** Peduncle sheath. **G & G1.** Flower, front & side views. **H.** Fruit. **I.** Dorsal sepal, dorsal view. **J.** Lateral sepal, dorsal view. **K.** Flower bud, side view. **L.** Lip, front view. **L1.** Lip, front view (highlighting the narrow hollow channel with minute hairs at the base). **M.** Floral perigon with spurred lip. **N.** Spurred lip(side view) with column, pedicel and ovary. **O.** Column, close view. **O1.** Column with pedicel & ovary. **P** & **P1.** Anther, front views. **Q.** Longitudinal section of spur. **R.** Pollinia with stipe. **S.** Stipe. *Pennilabium naja* P.O'Byrne (images taken from the spirit sample of the holotype *O'Byrne SUL107* at SING) **T.** Flower, side view. **U.** Floral perigon with spurred lip. **V.** Lip, front view. **W.** Anther, front view. **X.** Pollinia with stipe. (Photos: C. Deori & N. Odyuo)

Table 1. Comparison of *Pennilabium naja* and *P. labanyaeanum*.

Pennilabium naja	***Pennilabium labanyaeanum***
The flowers are fully open with yellow sepals and petals, about 12 mm wide.	The flowers are not fully open with pure white sepals and petals, 8–10 mm wide.
Sepals spreading with recurved tips, oblong obtuse, 3-veined, not keeled.	Sepals not spreading, broadly oblong obtuse, 5-veined, keeled dorsally at the apex.
Lip spurred, fleshy, tongue shaped, white with lateral wings at the base of the spur aperture; side lobes not distinct; midlobe ovate in outline, recurved in centre, epichile obtuse, lamina concave with rolled under margins, fleshy, rugulose, raised into a broad low ridge along median line from base of callus to just before lip apex.	Lip spurred, fleshy, sub-orbicular, white with no lateral wings; sidelobe absent; midlobe not recurved at the centre, epichile unlobed with erose margins, without a prominent raised callus but with an area of yellow powdery substance widening towards the lip apex.
Spur yellow, 9–10 mm long, slender.	Spur white, 5–7 mm long.

fleshy and solid. Most of the species in the genus fall into the first category. Two of the three species found in India, *Pennilabium proboscidcum* and *P. struthio*, have well developed side lobes, but the lip of the new species *P. labanyaeanum* lacks side lobes altogether, thereby separating it from all other species in the genus.

A key to the species of *Pennilabium* in India

1a. Lip sidelobes present, large and fimbriate 2
1b. Lip sidelobes absent ..... *P. labanyaeanum*

2a. Sepals and petals purple dotted, creamy white; lip sidelobes at least twice as long as broad at the truncate apex, which has erose-fimbriate edges .... *P. proboscidcum*
2b. Sepals and petals yellowish with dark red; lip sidelobes not twice as long as broad near the truncate apex, which has a rim of dense, branching lacinia .... *P. struthio*

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Tripogon bimucronatus (Poaceae: Chloridoideae: Tripogoninae), a new species from India

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ABSTRACT. *Tripogon bimucronatus* Thoiba & Sunil, a new species of grass from the Nelliyampathy Hills, Palakkad District of Kerala, South India is described and illustrated. It is morphologically similar to *Tripogon vellarianus* Pradeep but differs by having adaxially scabrid, linear-acuminate leaves; ligules a fringe of hairs to 2.5 mm long; spikelets with 6–8 closely packed florets; lower glume asymmetrical; upper glume awned; lemma awn scabrid; palea elliptic-lanceolate, apex bimucronate and notched at the centre.

Keywords. *Tripogon*, Poaceae, new species, Kerala, South India

Introduction

The genus *Tripogon* Roem. & Schult. belongs to subtribe Tripogoninae Stapf, tribe Cynodonteae Dumort, subfamily Chloridoideae Kunth ex Beilschm. in the family Poaceae Barnhart (Peterson et al., 2010, 2014; Soreng et al., 2012). The genus comprises 44 species distributed in Africa, America, Australia, Temperate and Tropical Asia (Clayton et al., 2006 onwards). It is known to have 22 species in India, which includes six recently described species (Murugesan & Balasubramaniam, 2008; Newmaster et al., 2008; Kabeer et al., 2009; Chorghe et al., 2013; Thoiba & Pradeep, 2014).

During an exploration along the Western Ghats of South India, an interesting specimen of *Tripogon* was collected from the hill slopes of the Nelliyampathy, Palakkad District of Kerala, South India. Critical study revealed it to be quite distinct from the remaining species of the genus and hence is described here as a new species, bringing the total number of *Tripogon* species for India to 23. It is closely allied to *Tripogon vellarianus* Pradeep (Pradeep & Sunil, 1999) but can easily be distinguished (Table 1).

Tripogon bimucronatus Thoiba & Sunil, **sp. nov.**
It is very similar to *Tripogon vellarianus* Pradeep but differs in having adaxially scabrid, linear-acuminate, ribbed leaves, ligules being hairy at the ends of leaf sheaths, with the hairs reaching up to 2.5 mm; spikelets with 6–8 closely packed flowers; the lower glume being asymmetrical, and the apex of upper glume awned; lemma 1-awned, scabrid, straight or geniculate; palea elliptic-lanceolate, apex bimucronate and notched

at the centre. – TYPE: India, Kerala, Palakkad District, Nelliyampathy hill top, 1200 m elevation, 16 November 2010, *Sunil, C.N. 4477* (holotype SING; isotypes BRIT, CALI, K). (Fig. 1, 2)

Tufted perennial herb. ***Culms*** 30–60 cm tall, erect; nodes glabrous. Leaf ***blades*** 30–60 cm long, 0.4–0.6 cm wide, linear, hispid towards base, apex acute-acuminate, scabrid adaxially, margins involute. ***Sheaths*** closely involute to the culm, almost rigid, sparsely hairy; *ligules* a fringe of hairs 2–2.5 mm long. ***Racemes*** 30–40 cm long, spikelets arranged along both sides, 45–65 spikelets per raceme; *peduncle* glabrous, terete, 10–15 cm long; rachis stout, minutely scaberulose, triangular. ***Spikelets*** linear-lanceolate, 1.3–1.8 cm long, 2–2.5 mm wide, 6–8-flowered; *callus* bearded. *Rachilla* not persistent, 1–2 mm long, slightly scabrid. ***Lower glume*** 3–3.5 × 0.5–1 mm, lanceolate, asymmetrical, notched on one-side below the middle, chartaceous, 1-nerved, apex acuminate. ***Upper glume*** 5–6 × 0.7–1 mm, elliptic-lanceolate, prominentely 3-nerved, glabrous, apex with awns 0.5–1 mm long. ***Lemma*** 5–5.5 × 1.5–2 mm (excluding awn), 3-nerved, 1-awned, the awn arising between lateral lobes, median awn 5–5.5 mm long, scabrid, straight or geniculate, lateral awns absent. ***Palea*** 4–5 × 1–2 mm, hyaline, narrowly elliptic, keeled and winged, keels minutely puberulous, apex bimucronate, notched at the centre. ***Lodicules*** 2, *c.* 0.25 mm, quadrate, apex coarsely 3-toothed. ***Stamens*** 3, *anthers* 1–1.5 mm long, oblong, *filaments* 0.5–0.75 mm long, slender, glabrous. ***Ovary*** 0.25–0.5 mm long, obovate; *style* 2, slender, hyaline, 1 mm long; *stigma* feathery, 1–1.5 mm long. ***Caryopsis*** 1.1–1.3 × 0.4–0.5 mm, narrowly oblong-lanceolate, obtusely trigonous, pale brown, obtuse at apex, longitudinally ribbed abaxially.

Distribution & Ecology. *Tripogon bimucronatus* usually grows in the granitic grassy slopes of Nelliyampathy Hills at an elevation of 1000–1200 m. It is found growing in association with *Arthraxon castratus* (Griff.) V. Naray. ex Bor, *Garnotia elata* (Arn. ex Miq.) Janowsky., *Cyanotis papilionacea* (Burm.f.) Schult. & Schult.f., *Swertia angustifolia* Buch.-Ham. ex D. Don., *Isachne bourneorum* C.E.C.Fisch., *Tripogon wightii* Hook.f., *Tephrosia pulchella* Hook.f., *Cymbopogon commutatus* (Steud.) Stapf, *Osbeckia* spp., *Parasopubia delphiniifolia* (L.) H.-P.Hofm. & Eb. Fisch., *Chrysopogon nodulibarbis* (Hochst. ex Steud.) Henrard, *Sopubia trifida* Buch.-Ham. ex D.Don, *Eulalia trispicata* (Schult.) Henrard, and various moss species. It also occurs along Meenuliyan Para Hills in Idukki District, Kerala at an elevation of 800 m.

Phenology. It flowers from early September to October. Fruit set is low with the seeds ripening by late October–November.

Etymology. The epithet 'bimucronatus' refers to the bimucronate palea apex.

Additional specimen examined. INDIA: **Kerala:** Idukki Dt., Meenuliyan Para, Vannappuram, 800 m elevation, 28 Nov 2014, *Sunil 4910* (SNM College Herbarium, Kerala).

Table 1. Comparison between *Tripogon vellarianus* Pradeep and *Tripogon bimucronatus* Thoiba & Sunil.

Tripogon vellarianus	***Tripogon bimucronatus***
Leaf blades 8–15 mm wide, glabrous on both surfaces	Leaf blades 5–8 mm wide, ribbed, slightly scabrid adaxially
Leaf sheaths closely clasping, very rigid; ligules membranous	Leaf sheath closely involute, almost rigid; ligules ciliate, 2–2.5 mm long
Spikelets distantly arranged, 8–10-flowered	Spikelets closely packed, 6–8-flowered
Lower glumes 4–5 × 1.25 mm, symmetrical, unlobed, acuminate at the apex	Lower glumes 3–5 × 1mm, asymmetrical, slightly 1-lobed on one-side, acute-acuminate at the apex
Upper glumes 5–7.5 × 1.5 mm, acute at apex, unawned	Upper glumes 5–6 × 1mm, a small awn between the sinus at apex, awns 0.5–1 mm long
Lemmas 5–10 × 2 mm (excluding awn), lateral awns absent or up to 5mm long, median awn 3mm long, glabrous,straight	Lemma 5–5.5 × 1–2mm (excluding awn),1-awned in between the lobes, awn 5–5.5 mm long, scabrid, straight or geniculate
Paleas c. 4 × 2 mm, elliptic, acute at apex	Paleas 4–5 × 1–1.2 mm, elliptic-lanceolate, bimucronate at apex with a notch at the centre

Key to the species of *Tripogon* in India
(with lemma entire or 2-cleft at apex)

1a. Lowest lemmas empty, dissimilar to other lemmas ..... *T. wardii*
1b. Lowest lemmas bisexual, similar to all other lemmas 2

2a. Culms thickened below by the persistent leaf sheaths; leaf blades equitant, rigid, apex pungent ..... *T. pungens*
2b. Culms not thickened below by the persistent leaf sheaths; leaf blades not equitant, not rigid or pungent 3

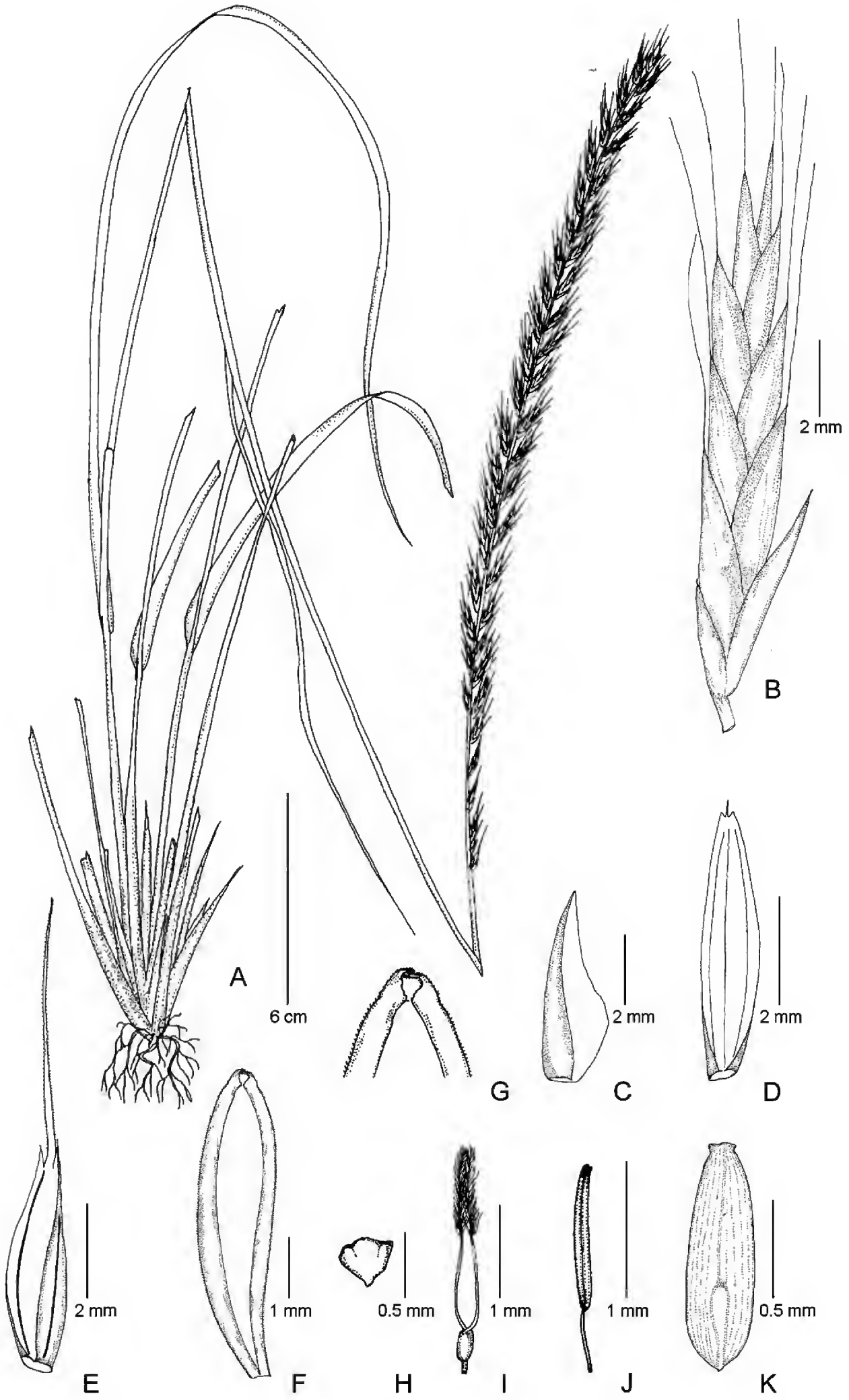

Fig. 1. *Tripogon binucronatus* Thoiba & Sunil **A.** Habit; **B.** Spikelet; **C.** Lower glume; **D.** Upper glume; **E.** Lemma; **F.** Palea; **G.** Portion of palea enlarged; **H.** Lodicule; **I.** Pistil; **J.** Stamen; **K.** Caryopsis. (A–J drawn from the holotype, K from *Sunil 4910*, all drawn by Thoiba Kottekkattu)

3a. Central awns of the lemmas flexuous, capillary, several times as long as lemmas ..... *T. capillatus*
3b. Central awns of the lemmas straight or curved, not more than twice as long as the lemmas 4

4a. Rachilla internodes 1 mm long; apices of lemmas 1-awned 5
4b. Rachilla internodes 2 mm long; apices of lemmas 3-awned ..... *T. copei*

5a. Culms 15–25 cm high; leaf blades 5–20 cm long 6
5b. Culms 30–90 cm high; leaf blades 30–60 cm long 7

6a. Upper glumes 5.5–7 mm long; awns of the lemmas 6–8 mm long, straight or curved ..... *T. wightii*
6b. Upper glumes 8–9.5 mm long; awns of the lemmas 10.5–12 mm long, always straight ..... *T. velliangiriensis*

7a. Leaf blades and culms glaucous, involute, filiform; ligules very short and ciliate ..... *T. jacquemontii*
7b. Leaf blades and culms green, flat, sometimes rolled; ligules obsolete 8

8a. Leaf blades 3–6 mm wide; racemes 7–25 cm long; median awns shorter than lemmas ..... *T. lisboae*
8b. Leaf blades 8–15 mm wide; racemes 30–40 cm long; median awn equal to or longer than lemmas 9

9a. Ligules membranous, a fringe of hairs at the ends of leaf sheath; paleas subulate at apex ..... *T. malabaricus*
9b. Ligules ciliate, membranous or absent; paleas not subulate at apex 10

10a. Upper glumes 3–4 mm long; lemmas 2.5–3.5 mm long 11
10b. Upper glumes 4–7.5 mm long; lemmas 4–10 mm long 12

11a. Ligules glabrous; lemma base glabrous, median awns as long as or shorter than the lemmas; inflorescence 20–45 cm long; spikelets with 5–8 florets ..... *T. sivarajanii*
11b. Ligules ciliate at apex; lemma base bearded; median awns 1.5 times longer than lemma; inflorescence 15–20 cm long; spikelets with 9–10 florets ... *T. tirumalae*

12a. Ligules a fringe of hairs; upper glumes awned at sinus; apex of paleas bimucronate ..... *T. bimucronatus*
12b. Ligules glabrous; upper glumes acuminate at apex; apex of paleas acute ..... *T. vellarianus*

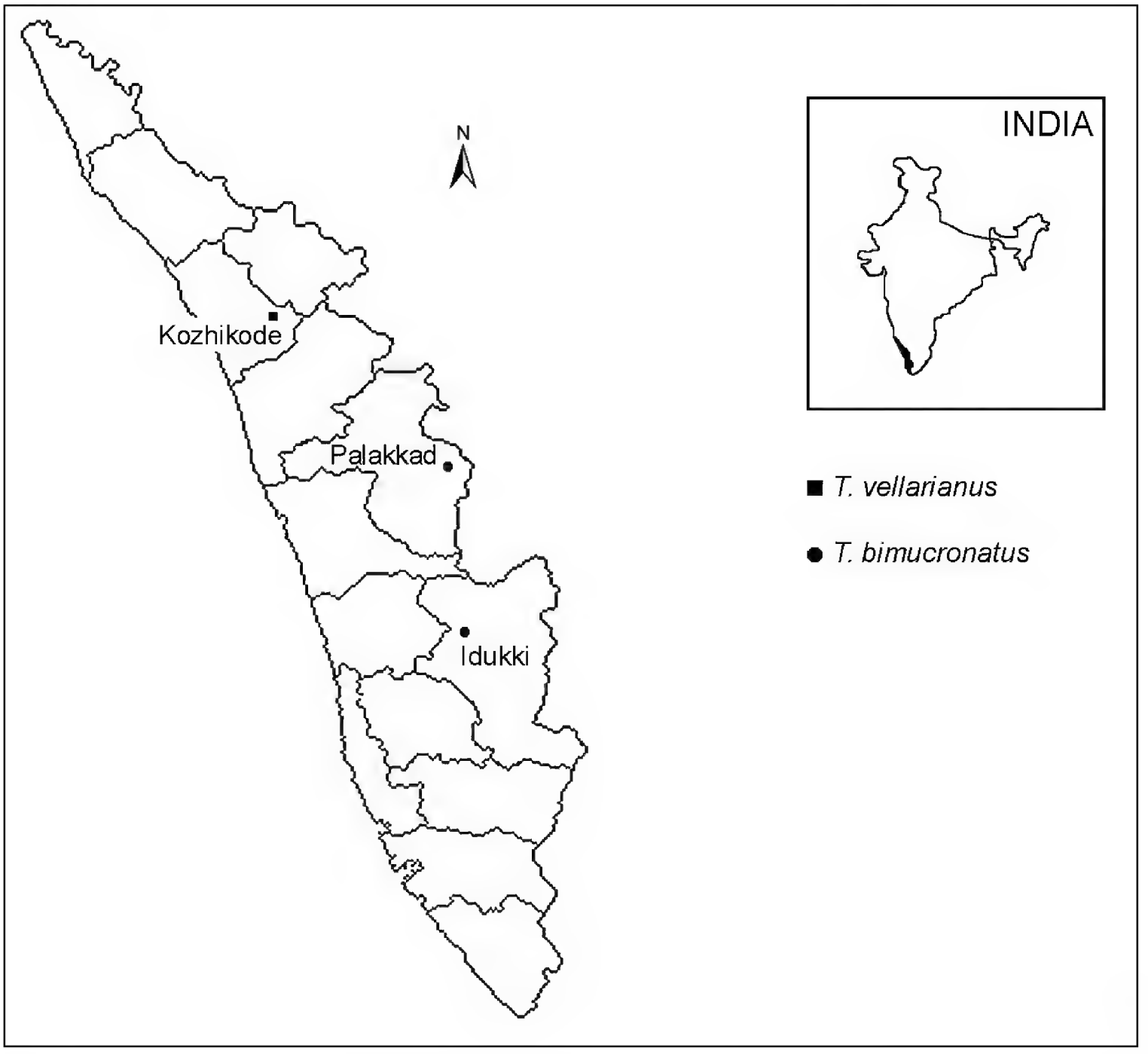

Fig. 2. Distribution map of *Tripogon vellarianus* Pradeep (■) and *Tripogon bimucronatus* Thoiba & Sunil (●) in Kerala

ACKNOWLEDGEMENTS. The authors are thankful to Dr K.H. Amitha Bachan, Western Ghats Hornbill Foundation (WGHF), Thrissur, Kerala for help during collection trips to the Nelliyampathy hills, Palakkad District of Kerala, and to the anonymous reviewers for useful suggestions that improved the text. The last author is thankful to the University Grants Commission, New Delhi for financial assistance.

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A revision of *Epithema* (Gesneriaceae)

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ABSTRACT. The genus *Epithema* Blume (Gesneriaceae) is revised. A key is given, all species are described and several are illustrated. Twenty species are recognised and two new combinations are made, *Epithema philippinum* (Hilliard & B.L.Burtt) Bransgrove and *Epithema pusillum* (C.B.Clarke) Bransgrove. Provisional IUCN conservation assessments are given for all species.

Keywords. Africa, *Epithema*, Gesneriaceae, Southeast Asia, taxonomic revision

Introduction

Epithema Blume is a genus of lithophytic herbs in central tropical Africa (Cameroon, Central African Republic, Democratic Republic of Congo, Equatorial Guinea, Guinea, Ivory Coast, Liberia, Sierra Leone and Uganda), South Asia (Nepal, India, Sri Lanka), Southeast Asia (southern China, Myanmar, Thailand, Vietnam, Cambodia, Laos, Taiwan), Malesia (Philippines, Malaysia, Indonesia) and the Solomon Islands.

The genus was first described by Blume (1826) with a single species, *Epithema saxatile* Blume. *Aikinia* R.Br. (in Wallich, 1832) was published shortly thereafter for a different species (*Aikinia brunonis*) but it was soon synonymised under *Epithema* by Decaisne (1834). Bentham (1835) and Spanoghe (1841) added further combinations or new taxa to *Epithema* but Don (1838) continued the use of *Aikinia*, placing *Epithema* in synonymy and moving *Epithema carnosum* to *Aikinia*. Later authors, however, correctly published treatments under the name *Epithema*. Major publications on the genus include two complete treatments of *Epithema* (Candolle, 1845; Clarke, 1883). Candolle (1845) included five species in his account and Clarke (1883) six species, of which five were from Asia and one from Africa. The account by Clarke (1883) also included eight new varieties and one new varietal combination. After 1883 there were occasional additional regional accounts and the descriptions of new taxa (Henriques, 1892; Chevalier, 1912; Merrill, 1916; Ohwi, 1943; Burtt, 1958; Kiew, 1985; Ying, 1992; Li & Kao, 1998; Wang et al., 1998) and a set of brief but valid publications of nine new taxa and combinations by Hilliard & Burtt (1997) in anticipation of a revision of the genus which, sadly, never materialised.

The classification of the Gesneriaceae into subfamilies, tribes etc. has been rather unsettled (Weber et al., 2013) with the result that *Epithema* has been placed in a number of different subfamilies, tribes and series. Burtt & Wiehler (1995) and Weber et al. (2013) both placed *Epithema* in the tribe Epithemateae (Meisn.) C.B.Clarke of the subfamily Didymocarpoideae (called Cyrtandroideae by Burtt & Wiehler (1995)). Weber et al. (2013) further placed it in its own subtribe, Epitheminae. Mayer et al. (2003), in a molecular phylogenetic study of the group, found that the Epithematoid Gesneriaceae are sister to the Didymocarpoid Gesneriaceae and that *Epithema* is monophyletic and sister to a clade with a single species each of *Loxonia* Jack and *Stauranthera* Benth. The study only included four species of *Epithema* (*E. tenue*, *E. saxatile*, *E. membranaceum* and *E. taiwanense* [= *E. ceylanicum*]) and, therefore, provides little information about the interrelatedness of the species within the genus.

In flower, *Epithema* is not easily confused with other genera although some specimens have been previously mistaken for *Monophyllaea* R.Br. due to a superficial resemblance to some species. The two genera can be separated by inflorescence arrangement, sepal shape and aestivation, placentation, the number of locules in the ovary, seed shape and hair type.

The species of *Epithema* are not readily distinguished from each other. Clarke (1883) suggested that the then known five Asian species could possibly be recognised as only one. Many are similar and there are few good characters to separate the species as both vegetative and reproductive characters can be variable. In particular, the species from mainland Asia are very similar and difficult to separate.

The gender of *Epithema* is neuter. Clarke (1883), however, described several new varieties with feminine endings. These have been corrected to neuter in the revision below.

Morphological Characters

Epithema is primarily lithophytic. In eastern and southeastern Asia it is found on limestone and, to a lesser extent, on granite and sandstone. It appears to be restricted to limestone in Borneo. In Africa, India and non-peninsular Myanmar it is found on volcanic rocks and soils. It requires shaded conditions with high humidity and is frequently found near or in cave entrances, on rocks on the forest floor, or on rocks beside, or in, shallow streams and rivers. Information from specimen labels indicates *Epithema* species will occasionally grow on fallen trees and is often collected from road sides and road side embankments.

All species of *Epithema* are small herbs. *Epithema*, like other didymocarpoid Gesneriaceae, is anisocotyledonous with the cotyledons withering early. The lowermost true leaf, however, is solitary and looks rather like the macrocotyledon found in other genera such as *Monophyllaea* (Weber, 2004).

The majority of species are caulescent but a few species have a very short stem with leaves arising more or less at ground level, therefore appearing acaulescent (*Epithema dolichopodum*, *E. longipetiolatum*, *E. philippinum*, *E. rennellense*, *E. strigosum* and some specimens of *E. benthamii*, *E. ceylanicum* and *E. tenue*). One

caulescent species, however, often exhibits a more sprawling rather than an upright habit (*E. sarawakense*) and one is unifoliate in most of its distribution (*E. horsfieldii*).

The hairs on all plant parts are simple, unbranched, straight or hooked, have 3–5 cells and are from 0.02 mm to (rarely) 1.5 mm long. Hooked hairs are usually shorter than straight hairs. The type of hairs (pubescent, strigose, setose, hispid or villous), density (glabrous to dense), colour (hyaline to brown) and length are quite variable. The combination of these characters is useful in some species but in others it is often too variable to be of any taxonomic use. It is, therefore, included in the descriptions only where it is taxonomically useful. Where 'minute hooked pubescence' is included in descriptions it denotes hooked hairs of a maximum of 0.1 mm long.

The leaves of *Epithema* are thinly to thickly membranous and are usually narrowly to broadly ovate, more rarely oblong to linear. The apex of the leaves is rounded to acute, the margin entire to serrate, dentate or crenate (or variations thereof) and the bases cordate to truncate to occasionally attenuate. The upper surface of the leaves is green to dark or black-green and the lower surface is usually lighter in colour than the upper surface and may dry whitish green to grey-green. Specimens of *Epithema saxatile* and *E. ceylanicum*, and possibly others, show some green and silver variegation on the upper surface of the leaves. The variegation has only been seen in a small number of specimens from Thailand and Peninsular Malaysia. The indumentum of the upper surface is variable in composition and the hairs are up to 1.5 mm long. The indumentum of the lower surface is similar to that of the upper surface but the hairs are usually sparser, shorter and finer. The indumentum of the leaves is occasionally taxonomically useful and is only included in the descriptions in those cases.

The leaf venation is cladodromous with the secondary veins mostly strongly ascending. There are often weaker intersecondaries and the tertiary venation is mostly fairly obscure but, when visible, laxly alternate percurrent. The number and arrangement of secondary veins is variable, between 4 and 15 and alternate to opposite (or both within one leaf), and not taxonomically important.

Leaf arrangement is variable. Caulescent species can have opposite or solitary leaves that in turn may be petiolate or sessile. A combination of all leaf arrangements may be found on one plant or within a population. Most acaulescent species have unpaired leaves. When present, solitary upper leaves are nearly always petiolate and opposite one or more peduncles.

Weber (2004) described the inflorescence of *Epithema* as "reduced to a single bract/inflorescence unit" which is derived from a "more elaborate thyrse, with several bract/inflorescence units in alternate position". The appearance is of a small, multi-flowered, scorpioid cyme. The flowers are arranged into rows, two to three across. The indumentum of the peduncle is glabrous to hispid with hairs to 1.25 mm long. The flowers are collectively subtended by one bract which is green and frequently cucullate, partially or entirely enclosing the inflorescence, but can be very small. The uppermost margin of the bract is usually dentate but can be entire to dentate. If the margin of the bract is lobed, the margin of the lobes may be entire, dentate or crenate. The indumentum of the lower surface of the bract is of a short, hooked pubescence and/or strigose to setose, straight and/or hooked hairs to 1 mm long. The indumentum

of the upper surface is usually of one hair type only, towards the margin and to 0.6 mm long.

The flowers mature sequentially from the base of the inflorescence towards the apex. The apex is always curved over to more or less horizontal and is often covered by the bract which subtends the entire inflorescence. The cells at the base of the inflorescence continue to grow so that the inflorescence changes position as flowers mature and the open flower is presented between the horizontal and around 45°. The number and size of the flowers in the inflorescence and the size and shape of the bract varies between and sometimes within species but the size of the bract is a useful character for the recognition of many species.

The pedicel is short, mostly up to only 5 mm long, and can elongate considerably at maturity but only rarely to as long as 7.5 mm. The calyx consists of five sepals that are fused from the base of the calyx to half or two-thirds the length of the sepals. It is actinomorphic, persistent and expands as it matures, providing a receptacle for the operculate capsule that sits in the centre of the calyx. The young calyx is generally oblong to obovate and becomes more campanulate at maturity. The lobes are linear to triangular, often becoming broader and acuminate in maturity. The shape of the calyx does not vary significantly between species.

The indumentum of the pedicel and calyx is similar to that on the bract and in many species is the same on both structures. Hairs on the pedicel are to 1 mm long, to 1.5 mm long on the outside of the calyx and to 0.5 mm long on the inside of the calyx. If present, the hairs on the inside of the calyx are usually strigose and found only on the lobes of the calyx. The combination of type and densities of the hair on the outside of the calyx is much more variable than on the inside of the calyx. Despite the variability it can be a useful character for species differentiation (e.g. *E. tenerum* and *E. steenisii*).

The corolla consists of a tube and five free corolla lobes in two lips. The tube accounts for approximately two thirds to three quarters of the length of the corolla. The smaller upper lip is of two lobes and the lower of three lobes. The upper lip is sometimes much smaller than the lower. The colour of the corolla is variable. Specimen labels indicate that the flowers may be white or pink, but usually the tube is white or of unstated colour and the lobes are blue to violet. The flowers of many species have irregular darker (purple) marks at the base of the lobes or in the upper throat.

In most species there are villous hairs on the inside of the corolla tube and there may be a minute pubescence on the outside of the lobes. The villous hairs are often in a dense band around the perimeter of the corolla tube and are usually placed somewhere between half way and two-thirds of the way up the tube and below the stamens. The tube is rarely glabrous or pubescent externally with short hairs inside. The presence and type of hairs inside the corolla is a useful character for separating some species of *Epithema*, while the hairs on the outside of the corolla lobes are not. Hairs inside the corolla can be difficult to see in rehydrated material. The hairs on the outside of the corolla can be difficult to observe and are not necessarily persistent. They are not included in the species descriptions.

The androecium consists of two fertile stamens and two staminodes. The staminodes are a filament with an arrow- or serpent's-head-shaped end. They are often

slightly shorter than the filaments of the fertile stamens. The stamens and staminodes are glabrous. The third, medial, staminode present in many Gesneriaceae is not seen in *Epithema*. The anthers are apically coherent, the thecae are divaricate and apically confluent. The stamens and staminodes are inserted on the top of a more or less square flap of androecial tissue which is in turn inserted on the wall of the corolla. The flap of tissue is up to 2.5 mm wide and high. The stamens are inserted on either end of the flap and the staminodes to the inside of each of them. The upper edge of the flap of tissue may be rounded leaving the staminodes at a slightly higher plane than the fertile stamens, up to 0.5 mm higher. The head of the staminode is frequently adjacent to, but not joined to, the back of the anther or the very top of the stamen filament. The style grows through the space between the flap and the two coherent anthers. The androecial tissue is normally inserted about half way to two-thirds of the way up the wall of the corolla tube, but can be placed higher in the tube. Irrespective of the position on the corolla tube, the placement of the stamens in relation to the staminodes does not change.

The nectary is comprised of one, two or three discrete lobes. In many species there are two lobes, one on each side of the ovary. Sometimes the nectary lobe(s) completely enclose the ovary, while in others the nectary is apparently absent. The composition of the nectary is variable within and between species and is not a good taxonomic character.

The ovary is superior, spherical to cylindrical and has one locule. The shape is variable and is not taxonomically useful. The placentation is parietal with two 'stalked' placentae, one on each side of the ovary. The placentophores are fused in their lower half to the ovary wall while the upper half supporting the placenta is free. This allows the formation of a dehiscent operculum in fruit. The ovules are produced from, and connected to, the placenta at the head of the placentophore by individual funicles. The upper portion of the ovary is usually pubescent and the lower portion is glabrous. Like the remainder of the plant, the indumentum consists of straight and/or hooked hairs. The hairs are not always entirely persistent, but density, length and shape of the hairs on the ovary are taxonomically useful. Unfortunately, the hairs are short (usually 0.1–0.3 mm long) and not easily observed and, therefore, are of limited use for field identification. The stigma is bilobed and the surface is covered in minute protrusions or papillae of c. 0.1 mm long. The style is slender and is inserted into the ovary in the centre of the upper margin of the ovary. The style may be glabrous to densely pubescent, the hairs being from 0.04–0.3 mm long and placed at the base of the style. Rarely are they up to mid-way on the style.

The fruit of *Epithema* is a circumscissile or operculate capsule which is oblong, obovate or sub-spherical in shape. The indumentum on the operculum is the same as on the ovary although it may be sparser. After fertilisation the style withers and breaks off leaving a small portion 0.3–2.3 mm long. This remnant is persistent and seen on the mature operculum. As the fruit matures, movement of the inflorescence brings the fruit into a vertical position, the calyx lobes grow and open widely outwards, leaving a basin-like structure in which sits the mature fruit. At maturity, the operculum is lost, leaving the seeds open to the elements. The hair on the operculum is a useful

taxonomic character, while fruit shape, size and length of the style remnant are not.

A large number of seeds is produced per capsule. The seeds are narrowly to broadly ovoid, rarely sub-cylindrical to slightly sigmoid in shape, with acute and/or constricted ends. They are not appendaged and they separate entirely from the funicle by which they connect to the placenta. They vary from light to dark brown and the ends are darker than the main body of the seed. Colour can vary between capsules of the same inflorescence and is certainly associated with stages of maturity, becoming darker with age. Some variation in colour might also be an artefact of drying.

The surface of the seed coat of all species of *Epithema* is arranged into more or less parallel lines that, when viewed under magnification, are darker than the remainder of the seed coat. The lines are straight to spiralled in the direction of the long axis of the seed and are between 0.02 and 0.05 mm apart. These longitudinal lines may fork and cross-walls are often present between the longitudinal lines. The density of the cross-walls and the forking does vary, giving some seeds a sub-reticulate look. Older descriptions place importance on the angle of the longitudinal lines, but angle of the pattern varies considerably even between seeds from one capsule or different capsules of one inflorescence. Scanning electron microscope (SEM) photographs of the seed of a small number of species of *Epithema* indicate that the surface of the seed is not taxonomically useful (Michael Moeller and Frieda Christie, pers. comm.). Further examination of the seed by SEM was not conducted in this revision. In only a few species is the length of the seed useful.

Splash cup dispersal is the primary means of seed dispersal in *Epithema*. The splash cups are formed from the persistent calyx and seeds are dispersed directly from the capsule, usually by raindrops. Splash dispersal is usually only effective over short distances but it is also possible that seed may be transported longer distances on the fur or the feet of animals, or in streams.

Materials and Methods

Approximately 1400 specimens from the following herbaria have been examined: A, AAU, ABD, BK, BKF, BM, BO, C, CAL, CALI, CMU, COI, E, G, GH, K, KEP, KLU, KYO, L, MSC, MO, NY, P, PDA, PNH, PSU, QBG, S, SAR, SING, TI, UPM, US and WAG (Thiers, continuously updated). These specimens were collected between the 1820s and 2014 from Cameroon, Central African Republic, Democratic Republic of Congo, Equatorial Guinea, Guinea, Ivory Coast, Liberia, Sierra Leone and Uganda, Sri Lanka, India, Nepal, China, Taiwan, Myanmar, Thailand, Laos, Cambodia, Vietnam, Malaysia, Singapore, Philippines, Indonesia, Timor Leste and the Solomon Islands. All specimens cited have been seen unless otherwise indicated. All measurements for vegetative characters, peduncles, bracts, pedicels and calyces are from dried specimen material. Measurements of other reproductive structures are taken from rehydrated material. Observations on herbarium material have been augmented by observations in the field (in Malaysia and Thailand) by both authors.

There are relatively few collections from areas such as eastern Thailand, Laos,

Cambodia, Vietnam, Sulawesi, Maluku, The Sunda Islands, Timor and Timor Leste, New Guinea and the many small islands of south-eastern Asia. In some of these areas *Epithema* species may genuinely be absent or scarce due to the lack of ideal habitats (e.g. absence of limestone) but collecting densities are known to be low in several of these areas (Johns, 1995; Middleton, 2003; Newman et al., 2007). Peninsular Malaysia and other areas of Thailand are relatively well collected.

Provisional conservation assessments are made using the methodology proposed by IUCN (2001).

The species are presented in alphabetical order as little data is available on relationships between the species. The dots on the maps represent the distributions of the specimens cited in this revision.

The flowering and fruiting times given are based on the data from herbarium specimens only and do not preclude flowering and fruiting at other times of year.

Constraints

Flowers in an *Epithema* inflorescence mature sequentially within the inflorescence with only one or few flowers fully expanded at any one time. In addition, the corolla is not persistent. It is, therefore, common for each specimen or sheet of specimens to contain no corolla material. This means that a thorough evaluation of infraspecific variability in corolla, stigma, style and stamen characters was limited by the availability of flowering material. When only immature flower buds were present they were dissected to gather character states for corolla and ovary pubescence. It is acknowledged that character states could change during the maturation process but we still found these bud characters useful.

For a number of species there are very few available specimens. This limits our understanding of the variability and distribution of the species.

Plant description, expedition date and/or geography data was limited or absent from many labels of the older specimens. For species with only small numbers of older specimens, distributions below country level are unattainable and transient character states such as corolla colour remain unknown.

Epithema Blume

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Aikinia R.Br. in Wall., Pl. Asiat. Rar. 3: 65 (1832). – TYPE: *Aikinia brunonis* Wall. (= *Epithema brunonis* (Wall.) Decne.).

Carpocalymna Zipp., Alg. Konst- Lett.-Bode 1: 297 (1829), nom. nud.

Herb, caulescent or acaulescent, occasionally only one leaf developing. ***Leaves*:** lowest leaf petiolate and solitary, upper leaves petiolate or sessile, opposite or alternate; blades thinly to thickly membranous, usually ovate to cordate, more rarely elliptic to orbicular, if asymmetrical then the wider side up to 1.75 times as wide as the narrower side, apex rounded to acute, base mostly cordate or sub-auriculate to obtuse, inserted evenly or unevenly on petiole, margin entire to crenate, serrate or (bi-)dentate, venation pinnate, upper surface pale to black-green, sometimes variegated, lower surface light to mid- or olive-green or purplish. ***Inflorescences*** 1–15(–many) per plant; peduncles usually originating from the leaf axils, occasionally from the petiole and/or the midrib of the blade; singular ***bract*** subtending each inflorescence, cucullate and enclosing the entire inflorescence to reduced, margin entire to dentate. ***Calyx*** cylindrical to campanulate, consisting of a tube and 5 lobes, with an embedded gland towards the apex of each lobe. ***Corolla*** tube usually white, lobes pale pink to blue or purple, commonly with darker markings on either lip; tube cylindrical to narrowly fluted, occasionally slightly constricted at the apex; lobes with margins entire to fimbriate. Stamens and staminodes inserted on top of flap of androecial tissue which is inserted in corolla tube; fertile ***stamens*** 2; anthers coherent at thecae tips or along entire thecae; staminodes 2, third staminode absent. ***Nectary*** apparently absent or one- to three-lobed, margin entire to undulate. ***Ovary*** cylindrical to spherical, glabrous to densely pubescent, unilocular, placentation parietal; style short; stigma bi-lobed, papillate, glabrous. ***Fruit*** (sub-) cylindrical to (sub-)spherical; operculum circumscissile or irregularly dehiscing at maturity, indumentum as ovary; surrounded by persistent calyx. ***Seed*** usually narrowly ovoid to broadly ovoid, ends acute and/or constricted, light to dark brown with darker ends, pattern straight to spiralled, walls of pattern usually splitting and merging and with cross-walls, occasionally walls of pattern appear thickened and rigid.

Twenty species from central tropical Africa, India, Sri Lanka, Nepal, southern China and through Southeast Asia and Malesia to the Solomon Islands.

Key to *Epithema* species

1a. First leaf arising more or less at ground level or from a very short stem 2
1b. First leaf arising above a definite stem 10

2a. Indumentum on ovary/operculum straight or primarily straight 3
2b. Indumentum on ovary/operculum hooked or primarily hooked, operculum rarely glabrous 8

3a. Ovary/operculum indumentum mostly villous with hairs to 1.5 mm long; corolla > 9 mm long; Africa ..... 20. *E. tenue* p.p.
3b. Ovary/operculum indumentum generally not villous, < 1 mm long (usually much less); corolla variable; Asia 4

4a. Hairs on ovary/operculum both straight and hooked; Solomon Islands .... 14. *E. rennellense* p.p.
4b. Hairs on ovary/ operculum straight only; not Solomon Islands 5

5a. Leaf margin entire or only minutely toothed, more rarely with larger and irregular teeth; Eastern Indonesia ..... 7. *E. longipetiolatum* p.p.
5b. Leaf margin distinctly toothed; widespread in Malesia 6

6a. Ovary/operculum hairs to 0.6(–1) mm long; upper leaf surface with only strigose to villous hairs with at least some hairs > 1 mm long; Philippines and eastern Malesia ..... 1. *E. benthamii* p.p.
6b. Ovary/operculum hairs to 0.3 mm long; upper leaf surface sometimes with minute hair covering as well as longer hairs but all hairs < 1 mm long; Philippines and Sumatra 7

7a. Leaves strongly crenate or with large, wide teeth with rounded apices; bracts > 10 mm long; Sumatra ..... 18. *E. strigosum*
7b. Leaves dentate/serrate, teeth narrow with pointed apices; bracts < 10 mm long; Philippines ..... 12. *E. philippinum*

8a. Hairs on ovary/operculum hooked or hooked and straight; corolla 10.4–15 mm long; Solomon Islands ..... 15. *E. rennellense* p.p.
8b. Hairs on ovary/operculum only hooked or operculum rarely glabrous; corolla 5–8.5 mm long; not Solomon Islands 9

9a. Inflorescences 1–5 per plant, usually large and not in fascicles; peduncles (2–)9–27 cm long; bracts 10–25 × 6–14 mm; operculum rarely glabrous; Sabah ..... 4. *E. dolichopodum*
9b. Inflorescences 1 to many, small, often different lengths, in fascicles; peduncles up to 10(–17) cm long; bracts 3–16(–20) × 3–10 mm; operculum with hooked hairs; continental Asia, Taiwan, Philippines .... 3. *E. ceylanicum* (rare acaulescent form)

10a. Ovary/operculum glabrous 11
10b. Ovary/operculum pubescent or at least with few hairs 14

11a. Plants with only 1 leaf, occasionally with 2 leaves, these never opposite; inflorescences arising from leaf blade midrib or junction of petiole and midrib ..... 5. *E. horsfieldii* p.p.
11b. Plants usually with more than 2 leaves, leaves alternate or opposite; inflorescences in the leaf axils or opposite a solitary leaf 12

12a. Upper leaves sessile ..... 9. *E. madulidii* p.p.
12b. Upper leaves petiolate 13

13a. Leaves all or primarily alternate; 1–5 peduncles arising in sequence from base of petiole; bracts large (10–32 × 6–12 mm) and usually enclosing inflorescence; plants with strigose or setose hairs, inner calyx glabrous or with sparse straight strigose hairs; Malesia .....15. *E. sarawakense* p.p.
13b. Leaves opposite; peduncles arising from leaf axils; bracts small (4–8 × 4–9 mm) and not enclosing inflorescence, plants glabrous to sparsely pubescent, inner calyx glabrous; southern India ..... 13. *E. pusillum*

14a. Plants with only 1 leaf, occasionally with 2 leaves, these never opposite; inflorescences arising from leaf blade midrib or junction of petiole and midrib, ovary hair hooked ..... 5. *E. horsfieldii* p.p.
14b. Plants usually with more than 2 leaves, upper leaves usually opposite; inflorescences from base of petioles or in the axils of upper petiolate or sessile leaves, rarely at base of midrib in the rare case leaves are alternate, 1–5 peduncles arising in sequence from base of petiole 15

15a. Upper leaves sessile 16
15b. Upper leaves petiolate 19

16a. Indumentum on ovary/operculum straight or primarily straight; Africa .... 20. *E. tenue* p.p.
16b. Indumentum on ovary/operculum hooked or primarily hooked; not Africa 17

17a. Corolla glabrous inside; Philippines ..... 9. *E. madulidii* p.p.
17b. Corolla pubescent inside 18

18a. Bract enclosing inflorescence, 13–35 × 8–12 mm ..... 16. *E. saxatile* p.p.
18b. Bract not enclosing inflorescence, 4–16 × 4–9 mm .....3. *E. ceylanicum* p.p.

19a. Indumentum on ovary/operculum straight or primarily straight 20
19b. Indumentum on ovary/operculum hooked or primarily hooked 24

20a. Indumentum on ovary to 1.5 mm long; Africa ..... 20. *E. tenue* p.p.
20b. Indumentum on ovary < 1 mm long; Asia 21

21a. Bracts cucullate, (2–)5–23 × (3–)4–11 mm; Philippines, eastern Malesia ... 22
21b. Bracts not cucullate, 1–13 × 2–9 mm; continental Asia and Peninsular Malaysia 23

22a. Leaves mostly not opposite, only occasionally so and then often of markedly different sizes; leaf margin entire or only minutely toothed, more rarely with larger and irregular teeth ..... 7. *E. longipetiolatum* p.p.
22b. Upper leaves usually opposite, only rarely upper leaves solitary; leaf margin distinctly and usually regularly toothed ..... 1. *E. benthamii* p.p.

23a. Bract small, rarely sub-cucullate or trullate, not enclosing inflorescence, 1–7 × 2–7 mm, margin often deeply lobed with 3 lobes; plants often with dense white hairs on most plant parts; corolla 4.2–5.4 mm long; Peninsular Malaysia ..... 11. *E. parvibracteatum* p.p.
23b. Bract small or sub-cucullate, enclosing a small portion of the inflorescence, 1–13 × 3–9 mm, margin entire to dentate; plants sub-glabrous to pubescent; corolla 5.5–7.5 mm long; Myanmar, China, India, Laos, Nepal, Thailand .... 2. *E. carnosum*

24a. Corolla glabrous inside ..... 6. *E. involucratum*
24b. Corolla with hair (villous) inside 25

25a. Leaves all or primarily alternate; 1–5 peduncles arising in sequence from base of petiole; bracts large (10–32 × 6–12 mm) and usually enclosing inflorescence; Malesia .....15. *E. sarawakense* p.p.
25b. Leaves primarily opposite; number and position of peduncles variable; bracts small to large and enclosing inflorescence or not; Continental Asia and Malesia 26

26a. Corolla > 10 mm long ..... 8. *E. longitubum*
26b. Corolla < 10 mm long 27

27a. Peduncles arising along petiole, often in fascicles, often many and of very different lengths ..... 3. *E. ceylanicum* p.p.
27b. Peduncles primarily arising from axils of leaves, usually singly or few and then of not remarkably different length 28

28a. Bract only rarely sub-cucullate or trullate but not enclosing the inforescence, 1–11 × 2–12 mm 29
28b. Bract sub-cucullate to cucullate enclosing a portion or all of the inflorescence, (3–)6–23 × 3–12 mm 31

29a. Lower to mid-style pubescent; calyx without hispid white hairs; delicate growth form ..... 10. *E. membranaceum*
29b. Style glabrous or with only a few hairs; calyx indumentum variable but with hispid white hairs; often with a robust growth form 30

30a. Plants with dense white hairs on most plant parts; Peninsular Malaysia .... 11. *E. parvibracteatum* p.p.
30b. Plants not densely pubescent; not in Peninsular Malaysia .... 3. *E. ceylanicum* (rare form with few inflorescences and smaller bracts)

31a. Bract usually enclosing only a portion of the inflorescence 32
31b. Bract usually enclosing most or all of inflorescence; corolla 6.5–9.5 mm long 33

32a. Plant 5–14(–20) cm; leaves often broadly lanceolate to narrowly ovate; corolla 5.2–6 mm long; Sulawesi ..... 19. *E. tenerum*
32b. Plant 4–40 cm; leaves usually cordate, ovate or elliptic; corolla 5–8.5 mm long; not in Sulawesi ..... 3. *E. ceylanicum* p.p.

33a. Calyx with strigose hairs only outside, hairs 0.5–0.8 mm long; Aceh .... 17. *E. steenisii*
33b. Calyx often glabrous, if hairs present these < 0.5 mm long; Myanmar, Thailand, Malaysia, Sumatra, Java, Borneo, Sulawesi ..... 16. *E. saxatile* p.p.

1. *Epithema benthamii* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 180 (1883). – TYPE: Philippines, Albay, 1841, *Cuming, H. 1265* (lectotype K [K000438696], designated here; isolectotype BM, K [K000438697]). (Fig. 1, 2)

Epithema brunonis var. *scabridum* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 178 (1883). – TYPE: Indonesia, Sulawesi, Gorontalo, *Riedel* s.n. (holotype K).

Epithema calcicola Ohwi, Bot. Mag., Tokyo 57: 125 (1943). – TYPE: Indonesia, West Papua, Waren, 60 miles south of Manokwari, 26 March 1940, *Kanehira, R. & Hatusima, S. 13143* (lectotype FU, image seen, designated here; isolectotype BO).

Herb 5–30 cm high, caulescent, occasionally appearing acaulescent with leaves at near ground level, sparsely to densely strigose and/or setose with hairs to 0.8 mm long, the lower bract, pedicel and the outside of the calyx also minutely pubescent with hairs to 0.2 mm long; stem 1–4 mm wide with 2–3 nodes, internodes 0.5–6.5 cm long. ***Leaves*** strongly membranous, upper leaves petiolate and opposite, infrequently with a solitary upper leaf; petiole of lowest leaf 2–13.5 cm long, upper petioles 0.2–6 cm long; blade of lowest leaf 4.3–14.5 × 2.2–7.5 cm; blades of upper leaves 2–12 × 1–6 cm, all leaves linear, narrowly ovate, or almost oblong, occasionally ovate or rhomboid, usually symmetrical, apex acute to rounded, base sub-cordate, rounded to truncate, occasionally sub-auriculate, usually inserted evenly on the petiole, margin usually irregularly serrate or biserrate; upper surface mid-green to black-green, sparsely to densely weakly strigose to villous, without minute hairs interspersed, straight hairs to 1.5 mm long, hooked hairs 0.5 mm long; lower surface generally lighter in colour than

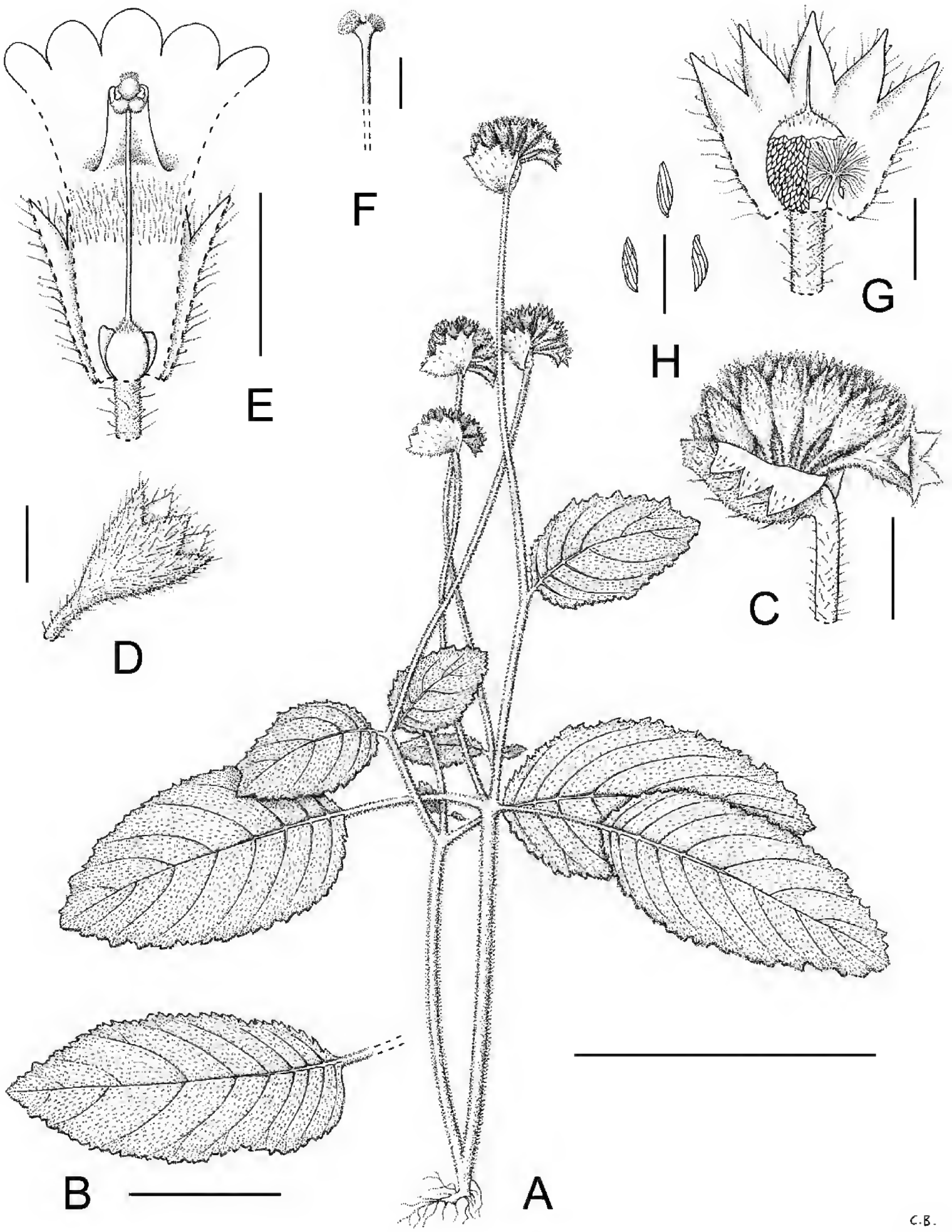

Fig. 1. *Epithema benthamii* C.B.Clarke. **A.** Habit. **B.** Leaf. **C.** Inflorescence. **D.** Calyx. **E.** Flower opened out. **F.** Stigma lateral view. **G.** Fruit showing seeds, placenta and operculum. **H.** Seeds. Scale bars: A = 6 cm, B = 3 cm, C = 5 mm, D = 3 mm, E = 4 mm, F = 1 mm, G = 2 mm, H = 0.5 mm. Drawn by Claire Banks from *Wenzel 437* (A, C–H) and *Coode 5313* (B).

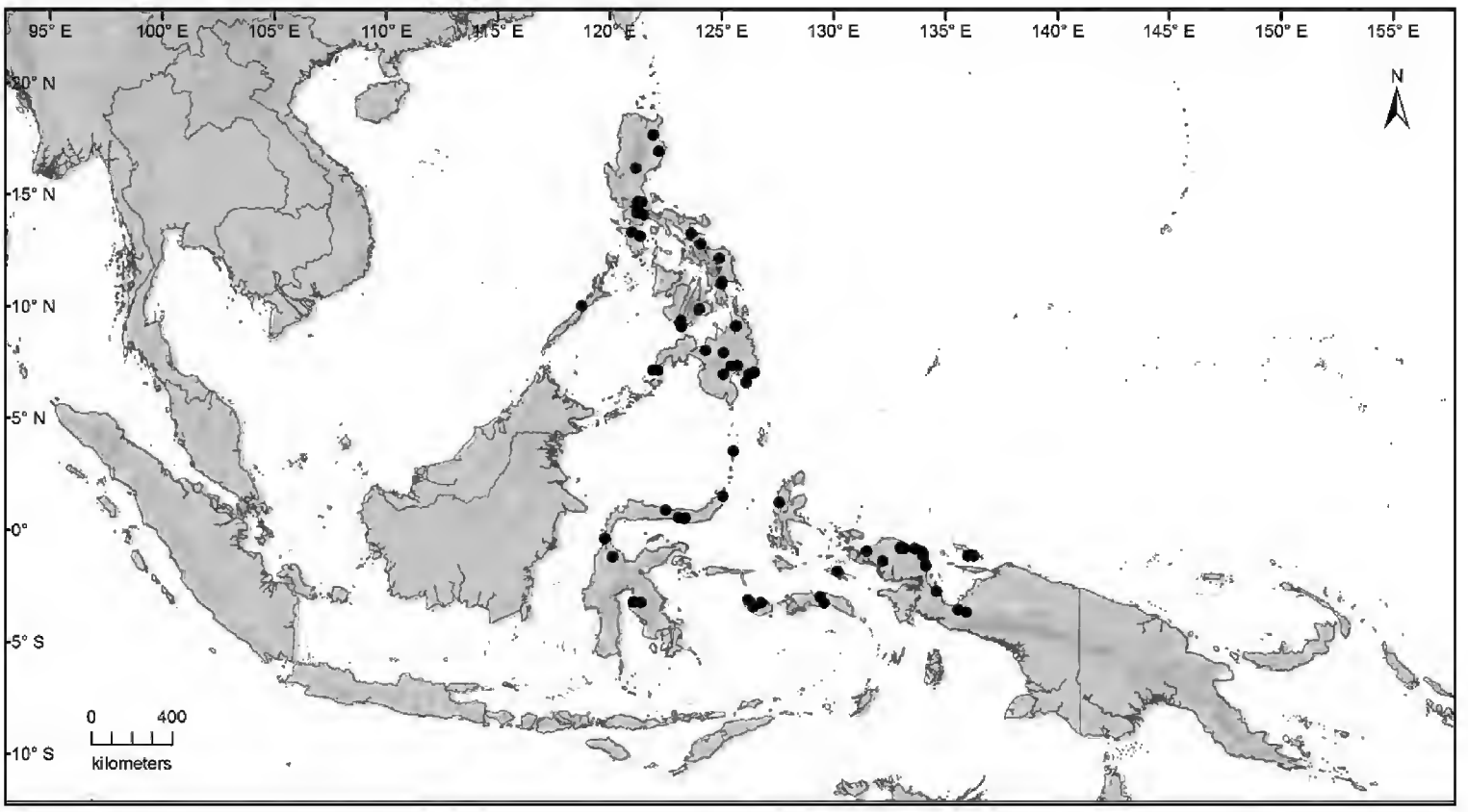

Fig. 2. Distribution of *Epithema benthamii* C.B.Clarke (●).

upper surface. ***Inflorescences*** 1–4(–6) per plant; peduncles 2.5–16 cm long, arising from leaf axils or, rarely, from the base of the uppermost petioles; ***bracts*** sub-cucullate or cucullate, enclosing a proportion of the inflorescence, occasionally reduced, (2–)7–23 × (3–)5–11 mm, margin usually dentate with large teeth but entire if reduced, lower surface with long strigose hairs 0.6–1 mm long, upper surface glabrous to pubescent at upper margin with hairs to 0.5 mm long; pedicels 1.5–4 mm long. ***Calyx*** 2.4–6 mm long; tube 1.7–3 × 1.5–2.5 mm; lobes 1.7–3 × 0.8–1.5 mm; glabrous inside, rarely with few straight hairs to 0.1 mm long in lobes. ***Corolla*** often white, but also blue to purple, 5–10 mm long; tube (4–)5–6(–8) × 1.3–2.5 mm; lobes 1–2 mm long. ***Stamens*** 1.4–1.5 mm long; filaments 1 mm long; anthers 0.4–0.5 mm long; staminodes 0.8–0.9 mm long. ***Nectary*** apparently absent or of two lobes, 0.8–1.4 × 0.6–1.1 mm, margin entire or occasionally notched. ***Ovary*** sub-spherical to spherical, 0.9–1 × 0.9 mm, densely pubescent to pilose, hairs straight or primarily straight with some hooked hairs (hooked hairs are shorter and often most easily visible on the fruit operculum), 0.1–0.6(–1) mm long, on very upper portion of ovary; style 2.9–4.2 mm long, usually glabrous, occasionally 1 or 2 hooked hairs on base of style, 0.2 mm long; stigma 0.4 mm wide. ***Fruit*** cylindrical, ovate or obovate, 2.1–2.3 × 1.7–1.9 mm; operculum 0.6 mm long, pubescence as on ovary. ***Seed*** narrowly ovoid to ovoid, 0.3–0.5 × 0.1–0.2 mm, medium brown, pattern spiralled and reasonably even.

Distribution. Indonesia (Sulawesi, Maluku (Buru, Seram), West Papua), Philippines.

Habitat and ecology. Lithophytic on both limestone and other rocks, but also occasionally terrestrial. Frequently found on stones and boulders in or beside streams

and rivers, but also in rock crevices in humid, shady, if not wet, places. Collected from 0–1600 m altitude.

Provisional IUCN conservation assessment. Least Concern (LC). This species is common and very widespread. However, as it frequently occurs on karst limestone, which is often commercially exploited, its status should be monitored.

Additional specimens examined: INDONESIA: **Maluku:** Buru, NW Buru, Bara, Waeduna River, 30 Nov 1984, *Nooteboom, H.P. 5357* (L); Buru, Nov 1984, *Sukendar SK740* (BO); Maluku, Buru, Ehoe, 27 Sep 1921, *Toxopeus, F.J. 358* (BO); Buru, Waeha, 12 Nov 1984, *van Balgooy, M.M.J. 4712* (E, L); Halmahera, Kampong Goal, *Idjan 175* (BO); ibidem, 14 Sep 1951, *Pleyte, D.R. 150* (BO, L); Seram, Tehoru, Saunulu, Murkele Ridge, 19 Feb 1985, *Kato, M. et al. C.6908* (L); Seram, Roho, 21 Nov 1917, *Kornassi 482* (BO). **Papua:** Chaban, 28 Feb 1940, *Kanehira, R. & Hatusima, S. 11848* (A, K). **Papua Barat:** Raja Ampat, Misool, Near Waima, 26 Sep 1948, *Pleyte, D.R. 1053* (BO); Vogelkop Peninsula, Aitinjoe, 11 May 1958, *Versteegh, C. BW7405* (L); Biak to Parieri, 11 Sep 1966, *Kostermans, A.J.G.H. & Soegeng 914* (BO, L); Biak, Kampong Saba, 31 May 1959, *de Wilde, J.J.F.E. 1155* (L); Biak, 29 Aug 1915, *Feuilletau de Bruyn, W.K.H. 335* (BO); Manokwari, Arfak Mts, Minjambau, 22 May 1962, *Versteegh, C. BW12694* (BO, L); Manokwari, Arfak Mts, Mupi Dessa, 16 Apr 1995, *Sands, M.J.S. 6841* (E, K); Manokwari, Arfak Plains, 25 Apr 1994, *Sands, M.J.S. 6337* (E, K); ibidem, 24 Apr 1994, *Sands, M.J.S. 6318* (K); Manokwari, Kebar Valley, Andjai Airstrip, Sobor Hills, 15 Nov 1954, *van Royen, P. 5063* (A, E, L); Manokwari, Kebar Valley, Andjai Village, 5 Nov 1954, *van Royen, P. 4946* (A, K, L); Manokwari, Mt Krabo, 3 Nov 1960, *Koster, C. BW10773* (A, L); Manokwari, Warmare, Mokwam Trail, 10 Apr 1994, *Sands, M.J.S. 6141* (K); Sorong, Warsamson Valley, 17 Aug 1961, *Schram, F.A.W. BW13259* (L); Wandammen Peninsula, Wondiwoi Mountains, 28 Feb 1962, *Koster, C. BW13665* (L); ibidem, 24 Feb 1962, *Schram, F.A.W. BW10631* (L). **Sulawesi:** s.l., 1871, *Riedel* s.n. (P). **Sulawesi Tengah:** Gunung Nokilalaki, 5 May 1975, *Meijer, W. 10045* (BO, L, US); Donggala, c. 57 km north of Palu on Palu-Oti Road, 3 Jun 1979, *van Balgooy, M.M.J. 3600* (L). **Gorontalo:** 9 Apr 2002, *Mendum, M. et al. 43* (E); Pinogu to Tulabolu, 15 Apr 2002, *Mendum, M. et al. 113* (BO, E); Gunung Boliohutu, *Mendum, M. et al. 180* (BO). **Sulawesi Tenggara:** Kesali-Porema, 23 Oct 1929, *Kjellberg, G.K. 2616* (BO, S). **Sulawesi Utara:** G. Klabat, Pinili, 31 Oct 1973, *Dransfield, J. 3869* (BO); Sangihe Island, Tamako, Kentuhang, 23 Nov 1998, *Hicks, D. 151* (K).
PHILIPPINES: **Agusan el Norte:** Cabadbaran, Mt Urdaneta, Aug 1912, *Elmer, A.D.E. 13470* (BO, E, G, GH, K, L, NY, P, US). **Bohol:** Aug 1923–Oct 1923, *Ramos, M. BS43313* (BO, G, K, P, US). **Bukidnon:** Jul 1913–Aug 1913, *Escritor, L. BS21452* (US); Mt Galintan, *Ramos, M. & Edaño, G. BS48897* (NY). **Cagayan:** Penablanca, Mar 1929–May 1929, *Ramos, M. BS76791* (GH, SING). **Davao del Sur:** Sep 1911–Oct 1911, *Weber, C.M. 1440* (E, NY, P). **Davao Oriental:** Baguan River, 8 Mar 1949, *Edaño, G. 758* (A, PNH); ibidem, 8 Mar 1949, *Edaño, G. 746* (PNH); Davao, Mati, Mar 1927–Apr 1927, *Ramos, M. & Edaño, G. BS49227* (NY); Davao, Mount Bilbogan, 1949, *Edaño, G. 1965* (A, L, PNH). **Davao del Norte:** Mt McKinley, 14 Aug 1946, *Edaño, G. 720* (PNH). **Ifugao:** Feb 1913, *McGregor, R.C. BS19951* (US). **Isabela:** Barangay San Jose, 7 Mar 1997, *Argent, G.C.G. et al. 29038* (E). **Laguna:** Los Banos, Apr 1906, *Elmer, A.D.E. 8318* (BO, E, G, K, NY); ibidem, 18 Dec 1903, *Hallier, H.G. 4128* (L); ibidem, 7 Mar 1906, *Merrill, E.D. 5106* (BO, K, NY, US); ibidem, 14 Jan 1905, *Williams, R.S. 2046* (NY); Mt Makiling, Jun 1917–Jul 1917, *Elmer, A.D.E. 18283* (BO, GH, K, US); ibidem, Jun 1917–Jul 1917, *Elmer, A.D.E. 17551* (BO, GH); ibidem, Jan 1913,

Robinson, C.B. BS17216 (US). **Lanao del Sur:** Lake Lanao, Camp Keithley, Sep 1906–Oct 1906, *Clemens, M.S. 724* (US). **Leyte:** *Wenzel, C.A. 231* (G, US); ibidem, 28 Jun 1913, *Wenzel, C.A. 437* (GH); Mt Abucayan, Feb 1923, *Edaño, G. BS41748* (G, K, US). **Negros Oriental:** Cuernos de Negros, Guinsuan Creek, 6 Jun 1948, *Edaño, G. 435a* (A); ibidem, 6 Jun 1948, *Edaño, G. 435* (PNH); Dumaguete, Cuernos Mts, Apr 1908, *Elmer, A.D.E. 9698* (BO, E, G, L, NY, US); Lake Balinsasayo, 16 Sep 1948, *Edaño, G. 418* (A, PNH). **Oriental Mindoro:** Subaan River, 14 Apr 1986, *Coode, M.J.E.* 5313 (K, L). **Palawan:** Mt. Kabangaan, Apr 1929, *Edaño, G.* s.n. (GH). **Quezon:** Mt Cristobel, 14 Dec 1996, *Reynoso & Majaducon PPI27265* (K). **Rizal:** Morong, 25 Mar 1893, *Loher, A. 4231* (K); Mt Angilog, Feb 1923, *Lopez, G. BS42049* (BO, L, P, US); ibidem, Feb 1923, *Lopez, G. BS42031* (US); Mt. Lumutan, Apr 1923, *Ramos, M.* 42176 (BO). **Samar:** Matuguinao, Baruz, 20 Jan 1952, *Gachalian, F. 147* (A, PNH); Mt Purog, 24 Dec 1951, *Edaño, G. 3478* (A); Mt Sarawag, 3 Dec 1951, *Edaño, G. 3070A* (PNH). **Sorsogon:** Irosin, Mt Bulusan, Apr 1916, *Elmer, A.D.E. 15877* (BO, C, G, GH, K, L, NY, P, US); ibidem, 1915, *Elmer, A.D.E. 15626* (BO, GH, NY). **Zamboanga:** Nov 1911–Dec 1911, *Merrill, E.D. 8222* (US); Sax River, 18 Feb 1905, *Williams, R.S. 2401* (NY).

Notes. There are two informal forms of *Epithema benthamii*. The typical form is found throughout the distribution of the species, while a finer, more thinly membranous and more elongate form is found on Buru Island (Maluku) and Biak Island off Papua (e.g. *Sands 6318*). These plants are similar to *Epithema longipetiolatum*, but still have the typical leaf form and the characteristic long, straight or primarily straight, hairs on the ovary and operculum of *E. benthamii*. The distributions of *Epithema benthamii* and *E. longipetiolatum* overlap on Buru Island and Biak Island. See further discussion under *Epithema longipetiolatum*. The indumentum of the leaf is useful for identification of *Epithema benthamii* in that there are no minute hairs interspersed between the larger hairs. The strigose hairs are often white, clearly visible and distinctive on the surface of the dried leaves.

The specimen *Kanehira and Hatusima 11848* (A) is unusual in that the peduncle is branched and racemosely bears many complete inflorescences.

In the type specimen of *Epithema brunonis* var. *scabrida* the leaves are somewhat dentate rather than entire as stated in the protologue, the indumentum is of the same form as *Epithema benthamii*, albeit slightly denser, and the hairs on the ovary/operculum are long and straight as in *E. benthamii* rather than the hooked hairs of *E. brunonis*. It is quite clearly a synonym of *Epithema benthamii*.

The only apparent difference between *Epithema calcicola* and *E. benthamii* is in the narrower somewhat reflexed bracts of *E. calcicola*. This species was known only from the type collection and we conclude it is only a rather unusual specimen of *Epithema benthamii* based on all other characters and that it occurs within the distribution of this species.

2. *Epithema carnosum* Benth., Scroph. Ind. 57 (1835); Barnett, Fl. Siam. 3(3): 205 (1962), p.p.; Wang et al., Fl. China 18: 400 (1998); B.L.Burtt, Thai For. Bull. (Bot.) 29: 93 (2001). – TYPE: Nepal, Nag Argute, 1832, *Wallich, N. s.n.* (lectotype K [K000438688], designated here). (Fig. 3)

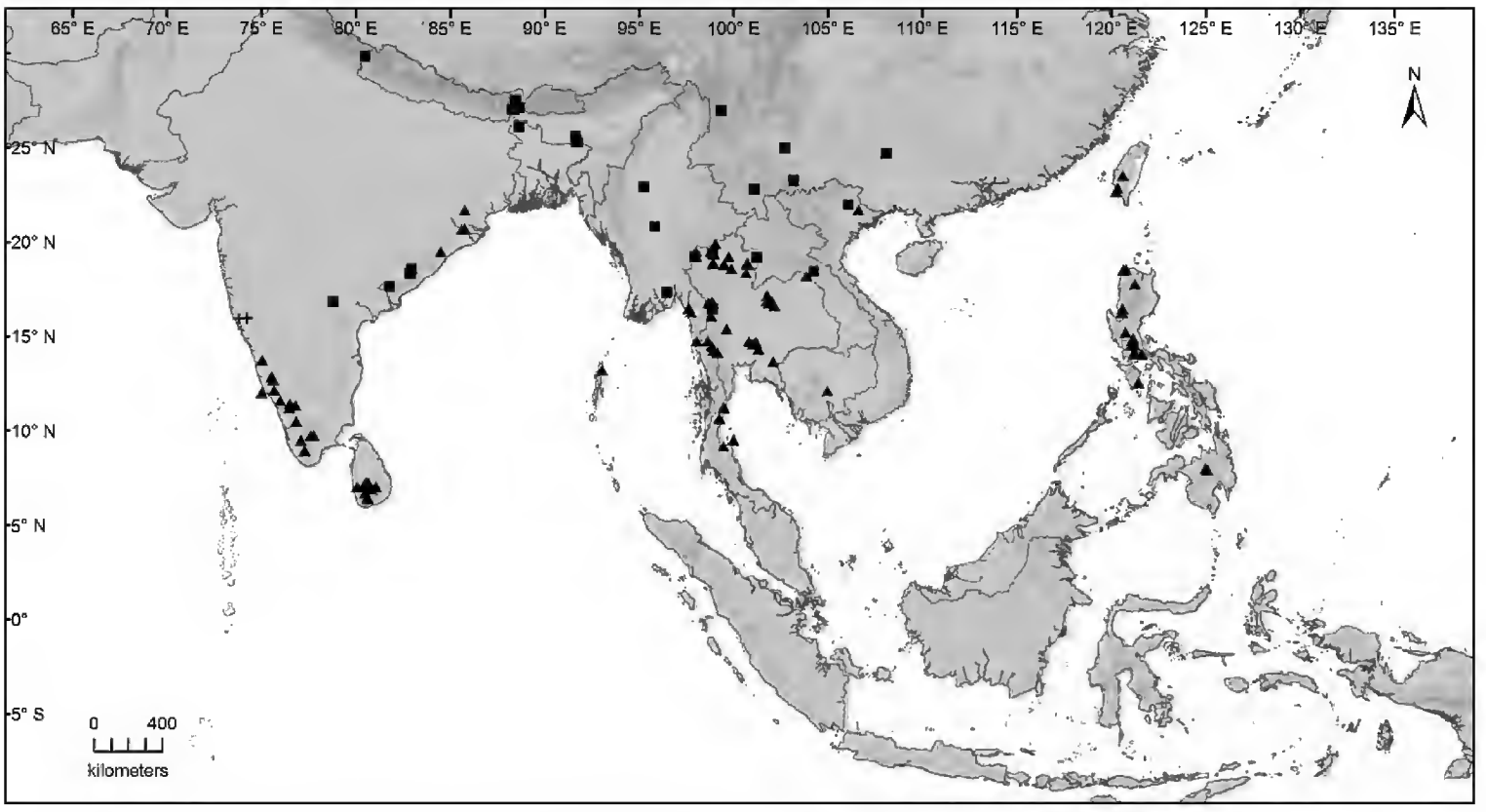

Fig. 3. Distribution of *Epithema carnosum* Benth. (■), *Epithema ceylanicum* Gardner (▲) and *Epithema pusillum* (C.B.Clarke) Bransgrove (+).

Herb 6–38 cm high, caulescent; stem 1.5–5 mm wide with 2–3 nodes, internodes 3–15 cm long, usually sub-glabrous to strigose or pubescent, rarely densely so. ***Leaves*** thinly membranous to membranous, lower leaf petiolate, upper leaves petiolate or sessile; petioles of lowest leaf 5–7.5 cm long, upper petioles 0–7 cm long; blades of the lowest leaf 6.5–17 × 6–12.5 cm, upper leaves 2.5–12.5 × 2.3–6 cm, sub-spherical, cordate or often ovate, symmetrical or barely asymmetrical, apex acute to broadly acute, occasionally rounded, base sub-cordate to truncate, inserted evenly on petiole or not, margin often sub-entire, but also serrate, dentate or crenate-sinuate (especially upper leaves); hairs on upper surface to 1.2 mm long; lower surface whitish-green or paler than upper surface. ***Inflorescences*** 1–12 per plant; peduncles 0.5–7 cm long, arising from leaf axils, from the petioles or from the leaf midribs, primarily from the upper leaves; ***bracts*** small or sub-cucullate, enclosing a small portion of the inflorescence, 1–13 × 3–9 mm, margin roughly entire with few dentate teeth to more dentate; pedicels 1–5 mm long. ***Calyx*** light or whitish-green, 3.3–5.4 mm long; tube 2–3.3 × 1.5–2.3 mm; lobes 1.3–2.1 × 0.7–1 mm; indumentum outside a minute hooked pubescence under strigose hairs 0.25–0.5 mm long. ***Corolla*** blue to dark purple, some with purple spots on the lower lip, 5.5–7.5 mm long; tube (3–)4–5.5 × (1–)1.5–2 mm long; lobes 1–2.3 mm long; glabrous outside, villous band of hair inside. ***Stamen*** filaments 0.6–0.8 mm long; anther dimensions unknown; staminodes 0.6–0.8 mm long. ***Nectary*** absent, of one lobe almost encircling ovary, or of two lobes, undulate, each end a distinctly different height from the other, 0.6–1 × 1.1–1.8 mm. ***Ovary*** sub-spherical, 0.5–0.83 × 0.4–0.75 mm, pubescent or pilose, medium to high density, hairs straight or primarily straight, hyaline, usually 0.1–0.25 mm long, occasionally to 0.4

mm long, on upper area of ovary; style c. 4 mm long, glabrous to pubescent, hairs sparse to high density, to one third or half way up style, hairs hooked, hyaline, to 0.1 mm long; stigma c. 0.5 mm wide. ***Fruit*** sub-cylindrical 2.1–2.5 × 1.7–2.5 mm; operculum c. 0.6 mm long, indumentum as ovary. ***Seed*** oval to fusiform, ends acute to constricted, 0.4–0.6 × 0.1–0.2 mm, medium brown, pattern often straight to more or less straight, but also to spiralled.

Distribution. India, Nepal, China, Myanmar, Thailand, Laos, Vietnam.

Habitat and ecology. Lithophytic. Found in humid, shaded places, often near water and in rocky crevices at 0–2120 m altitude. Flowering and fruiting April, July–October.

Provisional IUCN conservation assessment. Least Concern (LC). This species is very widespread. However, as it frequently occurs on karst limestone, which is often commercially exploited, its status should be monitored.

Additional specimens examined. INDIA: **Andra Pradesh:** Chintapalli, 31 Aug 1966, *Subba Rao, G.V. 28210* (E); Godavari, Rampa Country, Devarakonda, 6 Oct 1920, *Narayanaswami, M.A. 478* (CAL); Visakhapatnam, Araku, 24 Aug 1960, *Balakrishnan, N.P. 10815* (BSI, CAL, E). **Meghalaya:** Khasia, 28 Oct 1872, *Clarke, C.B. 19076* (US); Khasia, Cherrapunjee, 26 Aug 1850, *Hooker, J.D. & Thomson, T. 2161* (K); Khasia, Sohra, 22 Oct 1871, *Clarke, C.B. 15665* (L); Mont. Khasia, *Hooker, J.D. & Thomson, T.* s.n. (C, CAL, E, GH, L, NY, P). **Orissa:** Koraput, 8 Oct 1950, *Mooney, H.F. 4045* (K); Koraput, Pottangi, 10 Jul 1950, *Mooney, H.F. 3853* (K); ibidem, 13 Jul 1950, *Mooney, H.F. 3891* (K); Koraput, Turia Konda, 10 Oct 1950, *Mooney, H.F. 4092* (K); Sikkim, 1878, *King, G.* s.n. (CAL); ibidem, *Thomson, T.* s.n. (BO, L); ibidem, *Unknown 3847* (K); Sikkim, Mongpo, 5 Oct 1884, *Clarke, C.B. 36192* (G, K). **Uttaranchal:** Kumaon, 25 Sep 1884, *Duthie, J.F. 2990* (K). **West Bengal:** Darjeeling, *Unknown* 12200 (BO); Darjeeling, Mungpoo, 23 Sep 1875, *Clarke, C.B. 24805* (K); Darjeeling, Rishap, 2 Aug 1870, *Clarke, C.B. 12300* (CAL, L); Darjeeling, Rishap, Rishap Ravine, 4 Sep 1869, *Clarke, C.B. 8997* (L).
CHINA: Heou-hay tse, 7 Jul 1907, *Esquirol, J. 711* (E). **Guangxi:** Tan-Ngar, 12 Jul 1928, *Ching, R.C. 6421* (A). **Yunnan:** Shweli-Salwin Divide, 1917–1919, *Forrest, G. 15699* (E, K); Simao, *Henry, A. 13497* (K, US); ibidem, *Henry, A. 12280* (K); ibidem, *Henry, A. 12705* (K).
MYANMAR: Pegu, *Scott 3* (L); Mandalay, Meiktila, Taungbaw-yo, 22 Oct 1936, *Smith, H.C. 16273* (K); Mandalay, Myingyan, Pope Hill, 4 Aug 1909, *Lace, J.H. 4892* (E, K).
THAILAND: **Chiang Mai:** Chiang Dao, Doi Chiang Dao, 22 Jul 1989, *Maxwell, J.F. 89-920* (L); ibidem, 27 Sep 1971, *Murata, G. et al. 15146* p.p. (C, K, KYO); ibidem, 27 Sep 1971, *Murata, G. et al. T.15156* (KYO); ibidem, 19 Oct 1926, *Put 410* (K); ibidem, 26 Oct 1979, *Shimizu, T. et al. T.20909* (KYO). **Mae Hong Son:** Muang, Doi Mae Sakut, 23 Sep 1995, *Nanakorn, W. et al. 4664* (E). **Nan:** Sapan Waterfall, 7 Sep 1995, *Larsen, K. et al. 46161* (AAU). **Tak:** Nam Tok Phacharoen National Park, 23 Apr 2004, *Pooma, R. et al. 4580* (BKF).
LAOS: **Sayaboury:** Phiang, Nam Phon, 1 Sep 1999, *Maxwell, J.F. 99-278* (A, L).
VIETNAM: **Bac Kan:** Na Ri District, Liem Thuy Municipality, Na Bo Village, 15 Jul 2004, *Atha, D. 4785* (NY); **Ha Giang:** Pho Bang, Pho Cao, 12 Aug 1977, *Phuong, V.X. 311* (HN).

Notes. Epithema carnosum is widespread across tropical Asia with the exception of Malesia. It is similar to some of the forms of *Epithema ceylanicum* and was originally

separated from it (as *E. dentatum*) by *E. carnosum* having crenate-sinuate leaves vs. *E. dentatum* having small teeth on the leaf margin that are sometimes subacute or doubly serrate. Also *Epithema dentatum* was said to have shorter petioles on the upper leaves. These characters cannot consistently be used to separate *Epithema carnosum* from the now more broadly defined *E. ceylanicum* which includes *E. dentatum*. It is better separated from *Epithema ceylanicum* by the hairs on the ovary and operculum. They are straight in *E. carnosum* and hooked or primarily so in *E. ceylanicum*. In nearly all specimens from India, Nepal and Myanmar there is no variation in this character, but on specimens from China, Thailand and Vietnam a proportion of the hairs on the ovary/operculum of *Epithema carnosum* may be hooked. In all cases where the majority of the hairs are straight, the specimens are assigned to *E. carnosum*. This is also essentially true of *Epithema ceylanicum* where the hairs on almost all specimens from India and Myanmar have only hooked hairs on the ovary and operculum but some specimens from north and north-west Thailand also have some straight hairs on the ovary/operculum. In all cases where the majority of the hairs are hooked, the specimens are assigned to *E. ceylanicum*.

Epithema carnosum occasionally produces peduncles from the petioles of the leaves of the terminal leaf pair. Peduncles arising from the midrib of these leaves has only been observed in specimens of *Epithema carnosum* from Khasia in Northeast India.

3. *Epithema ceylanicum* Gardner, Calcutta J. Nat. Hist 6: 492 (1846). – *Epithema carnosum* var. *ceylanicum* (Gardner) C.B.Clarke in A.DC. & C.DC. Monogr. Phan. 5(1): 178 (1883). – TYPE: Sri Lanka, *Gardner, G. 606* (lectotype K, designated here). (Fig. 3–5)

Epithema carnosum var. *hispidum* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 178 (1883). – *Epithema dentatum* subsp. *hispidum* (C.B.Clarke) Hilliard & B.L.Burtt, Edinburgh J. Bot. 54: 112 (1997). – TYPE: India, Tamil Nadu, Western Ghats, Courtallum, August 1835, *Wight, R. 2350* (lectotype K, designated here)

Epithema carnosum var. *dentatum* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 177 (1883). – *Epithema dentatum* (C.B.Clarke) Hilliard & B.L.Burtt, Edinburgh J. Bot. 54: 111 (1997). – TYPE: Burma, Mon, Moulmein, Farm Cave Rocks, *Parish, C.S.P. 63* (lectotype K, designated by Hilliard & Burtt (1997)).

Epithema brunonis var. *fasciculatum* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 180 (1883). – *Epithema taiwanense* var. *fasciculatum* (C.B.Clarke) Z.Yu Li & M.T.Kao, Fl. Taiwan ed. 2, 4: 697 (1998). – TYPE: Philippines, Tayabas, 1841, *Cuming, H. 823* (lectotype K [K000438698], designated here; isolectotype BM, G-DC, K, L, P).

Fig. 4. *Epithema ceylanicum* Gardner. Leaves and inflorescences. (Photo: Preecha Karaket)

Fig. 5. *Epithema ceylanicum* Gardner. Flowers. (Photo: Preecha Karaket)

Epithema taiwanense S.S.Ying, Coloured Ill. Fl. Taiwan 4: 795 (1992); Li & Kao, Fl. Taiwan ed. 2, 4: 697 (1998); Wang et al., Fl. China 18: 400 (1998). – TYPE: Taiwan, Chia-yi, Kuanyin waterfalls, 200–300 m, 25 June 1992, *Ying, S.S. s.n.* (holotype NTUF n.v.).

Herb 4–40 cm high, caulescent or with very short primary internode and appearing acaulescent; stem 1–10 mm wide, internodes 0.5–15 cm long, sub-glabrous, sparsely strigose or sparsely pubescent, hairs 0.5–1 mm long. ***Leaves*** thinly to strongly membranous, lowest leaf always petiolate, upper leaves sessile to petiolate, sometimes with a solitary upper, sessile leaf per plant; petiole of lowest leaf (0.2–)1–12 cm long, sub-glabrous to densely pubescent, hairs to 0.7 mm long, petioles of upper leaves 0–2 cm long, sub-glabrous, minutely pubescent or with longer hairs of medium to high density, to 1 mm long; blades of lowest leaves 3–20 × 1.8–20 cm, upper or solitary leaves (1–)1.5–11 × 0.8–7 cm, lower leaves cordate to ovate, upper leaves cordate, ovate or elliptic, occasionally almost oblong or sub-spherical, symmetrical or asymmetrical, apex acute to rounded, base of lower leaf cordate to truncate, base of upper leaves obtuse, rounded or truncate, occasionally sub-cordate, inserted evenly on petiole or not, where inserted unevenly one side is often cordate, the other truncate, margin sub-entire to dentate, bidentate or serrate; upper surface pale- to mid-green, with sparse straight and/or hooked hairs to 0.9 mm long and sparsely to densely strigose, hairs 0.25–1.5 mm long; lower surface paler green or purplish in colour, sub-glabrous to strigose, hairs sparse to medium density, sometimes with hooked and straight hairs on veins to 0.3 mm long. ***Inflorescences*** 1–6 (to many) per plant; peduncles arising from the leaf axil, the petiole or the base of the midrib, usually from the upper leaves, often rather fasciculate, (0.1–)1–10(–17) cm long, often of very variable lengths in a single cluster, sub-glabrous to densely setose, hairs to 1.1 mm long; ***bracts*** (sub-)cucullate but enclosing a small proportion of the inflorescence if at all, 3–16(–20) × 3–9(–10) mm, 0.6–2(–3.4) times as long as wide, margin entire to partially or entirely dentate; lower surface glabrous to strigose, hairs sparse to medium density, hairs 0.25–0.8 mm long, with or without shorter layer of hair 0.1–0.4 mm long; upper surface glabrous to sparsely strigose, hairs to 0.25 mm long, hairs on upper half of bract or towards margins; pedicels 0.5–6 mm long, densely pubescent with fine minute hairs and more sparsely with larger strigose hairs to 1 mm long. ***Calyx*** 2.1–8 mm long; tube 0.8–6 × 1–2.9 mm; lobes 1–2.5 × 0.7–2.1 mm; sub-glabrous or sparsely to densely pubescent outside with fine, minute straight and hooked hairs to 0.25 mm long, with or without sparse, strigose hairs, to 0.4 mm long; glabrous or subglabrous inside, sometimes with strigose hairs on inside of lobes. ***Corolla*** whitish or blue, blue-violet or pink, tube white, 5–8.5 mm long; tube 3.2–6.3 × 1–3 mm; lobes 1–3 × 1–1.3 mm long, margins often slightly fimbriate; glabrous to sparsely pubescent outside on lobes, hairs straight; dense band of villous hair inside, one-third to three-quarters way up the tube from the base. ***Stamens*** 1.4–2.1 mm long; filaments 1–1.7 mm long; anthers 0.4–0.5 mm long; staminodes 1–1.7 mm long. ***Nectary*** apparently absent or one or two discrete lobes, may almost encircle ovary or not, margin entire or sub-entire, undulate or notched, 0.8–1.8 × 1–1.8 mm. ***Ovary*** sub-spherical to cylindrical, 0.7–1.5 × 0.9–1.5 mm,

sparsely to densely pubescent on the upper half or uppermost part of the ovary, hairs hooked or primarily hooked, hyaline, to 0.15 mm long; style 2.5–5 mm long, glabrous or sparsely pubescent in lower half, hairs hooked; stigma to 0.5–0.8 mm wide. ***Fruit*** spherical to cylindrical, 1.5–5 × 1–3 mm; operculum 0.4–0.8 mm long, sparsely to densely pubescent as on ovary. ***Seed*** sub-cylindrical to ovoid, 0.4–0.7 × 0.1–0.2 mm, pattern often straight or almost straight, but also to spiralled, regular, walls clearly defined, often appearing thickened and rigid.

Distribution. India (including Andaman Islands), Sri Lanka, Taiwan, Myanmar, Thailand, Cambodia, Vietnam, Philippines.

Habitat and ecology. Lithophytic. Found on rocks and rock faces in wet, humid, shady places, occasionally on wet tree trunks at 0–2000 m altitude.

Provisional IUCN conservation assessment. Least Concern (LC). This species is very widespread. However, as it frequently occurs on karst limestone, which is often commercially exploited, its status should be monitored.

Additional specimens examined. INDIA: **Andaman and Nicobar Islands:** North Andaman, Saddle Peak National Park, 10 Feb 2000, *Sumathi, R. 17895* (K). **Karnataka:** Chorla Ghats, Chorla, *Stocks* s.n. (K); Coorg, Mercara, Jersey Falls, 12 Sep 1934, *Barnes, E. 928* (K); Mysore, Hassan, Bisle ghat, 14 Aug 1971, *Ramamoorthy, T.P. HFP2007* (US); Mysore, Hassan, Shiradi ghat, 7 Aug 1969, *Saldanha, C.J. 14426* (US); Mysore, Kenchankumri State Forest, 15 Aug 1971, *Ramamoorthy, T.P. HFP2035* (K, US); Mysore, Shimoga, Hulical ghat, 24 Aug 1963, *Raghavan, R.S. 90185* (E). **Kerala:** Idikki District, Sabarimalai slopes, 26 Sep 1972, *Sharma, B.D. 42032* (E); Kochi (Cochin), Parambikulam, 25 Sep 1935, *Barnes, E. 1300* (K); Kochi (Cochin), Parambikulam Hills, Dec 1934, *Barnes, E. 1056* (K); Palghat, Silent Valley, 21 Aug 1966, *Vajvavelu, E. 27558* (L). **Madhya Pradesh:** Bastar, Upper Kanger Valley, 26 Aug 1959, *Subramanyam, K. 8644* (E). **Maharastra:** Concan, *Hooker; J.D. & Thomson, T.* s.n. (P); ibidem, *Stocks, Law & co.* s.n. (C, L). **Orissa:** Dhenkanal State, Goyalpathar ghati valley, 16 Sep 1942, *Mooney, H.F. 2067* (K); Dhenkanal State, Kapilas Hill, *Mooney, H.F. 2754* (K); Dhenkanal State, Saptasajya, 20 Sep 1993, *Dhal, N.K. & Rout, N.C. 8122* (E); Ganjam, Budhakhol Pahad, 14 Aug 1971, *Brahmam, M. 2776* (E). **Tamil Nadu:** Banliyar, *?Wight* s.n. (L); ibidem, *?Wight* s.n. (L); Madurai, Way, 14 Oct 1959, *Subramanyam, K. 8975* (E); Mont. Nilghiri & Kurg, *Thomson, G.* 121 (K); ibidem, *Thomson, G.* s.n. (E, G); Vilangadu Forest, 27 Aug 1985, *Pradeep, A.K. 5850* (CAL); Western Ghats, Courtallum, *W. C. 2680* (E); ibidem, *Wight, R. 556* (K); Western Ghats, Courtallum, Swamiar Falls, 2 Oct 1975, *Nair; K.K.N. 1354* (CALI). **West Bengal:** Kolcata, Kabini tributory falls, 17 Aug 1964, *Ellis, J.L. 20452* (E).
SRI LANKA: s.l., 1891, *Deschamps* s.n. (G); *Mrs. General Walker 140* (K); *Mrs. General Walker* s.n. (K); *Thwaites, G.H.K. 2844* (BO, G, K, P); 1836, *Wight, R. 1/162* (K). **Uva:** Badulla District, Between Mesitale and Dunhinda Falls, 26 Jan 1982, *Namba, T. & Mikage, M. 82-413* (KYO); Badulla District, Dunhinda Falls, 8 Jan 1983, *Lucas 1025* (US). **Central:** Matale District, Wiltshire Forest, 2 Jul 1974, *Sumithraarachchi, D.B. DBS388* (K); Deltotte, Nov 1888, *Unknown* s.n. (SING); Kandy, Laksapana, 19 Sep 1972, *Jayasuriya, A.H.M. 843* (US); Peradeniya, 10 Sep 1934, *Unknown 753* (L). **Sabaragamuwa:** Kegalle District, Dolosbage, Windsor Forest, 17 Nov 1978, *Grey-Wilson, C. & Grey-Wilson, C.M. 3016* (K, US); Kegalle District, Kadaganawa, 1 Sep 1969, *Grupe, D.A. 200* (US); ibidem, 22 Aug 1968, *Theobald,*

W.L. & Grupe, D.A. 2404 (US); ibidem, 30 Jul 1968, *Theobald, W.L. & Grupe, D.A. 2368* (US); Ratnapura, Katussagala Hill, 5 Dec 1976, *Faden, R.B. & Faden, A.J. 76/494* (US); Ratnapura, Pannil Kanda, 5 Jul 1975, *Waas, S. 1407* (K); Ratnapura, Rakwana, 7 Dec 1977, *Fosberg, F.R. 57278* (K, US).
TAIWAN: Takow, Ape's Hill, *Henry, A. 1916* (E, K, NY, US); Kaohsiung Hsien, Shuangchi, Meilong, 31 Oct 1988, *Hsieh, C.F. et al.* s.n. (E); Kaohsiung Hsien, Takangshan, 14 Nov 1988, *Yang, K.C. 3465* (E).
MYANMAR: **Mon:** Moulmein, Jul 1880, *Brandis, D. 676* (K); ibidem, *Lobb, T. 387* (K); ibidem, *McKee, H.S. 1958* (P); ibidem, *Parish, C.S.P. 133* (K); Moulmein, Kyauk Ta Lon, Jul 1958, *McKee, H.S. 6317* (K, P).
THAILAND: **Bueng Kan:** Mueang, Chaiyaphon, Singhanat Ban Phot Temple, 26 Aug 2001, *Pooma, R. et al. 2697* (BKF). **Chiang Mai:** Chiang Dao, *Pooma, R. 1059* (BKF); ibidem, 16 Jul 1958, *Smitinand, T. 4719* (BKF); ibidem, 15 Aug 1963, *Smitinand, T. & Sleumer, H.O. 1006* (BKF); Chiang Dao, Doi Chiang Dao, 27 Sep 1971, *Murata, G. et al. 15146* p.p. (L); ibidem, 17 Jul 1958, *Sorensen, T. et al. 4235* (A, BKF, C, E); Chiang Dao, Doi Chiang Dao, Between Pong Pho and Khun Klong, 31 Jul 1968, *Larsen, K. et al. 2923* (AAU); Doi Sutep, 10 Oct 87, *Maxwell, J.F.* 87-1154 (BKF, L); ibidem, 12 Sep 1958, *Sorensen, T. et al. 4936* (ABD, C); Mae Ram Subdistrict, Doi Sutep-Pui National Park, Mae Ram Stream, 10 Sep 1992, *Palee, P. 73* (A, CMU, GH, L); Fang, Doi Ang Khang, 21 Sep 2008, *Middleton, D.J. et al. 4544* (E); Mae Dang, Mawn Ngaw, Doi Mawn Ngaw, 12 Aug 2002, *Palee, P. 544* (L). **Chumphon:** Sapli, 8 Sep 1927, *Put 1015* (ABD, K). **Kanchanaburi:** 15 Aug 1968, *Nimanong, B. & Phusomsaeng, S.* 288 (BKF); ibidem, *Suvanakoses, P. 2060* (BKF); Kanburi, Baw Re, 21 Jul 1926, *Put 219* (K); Sai Yok, Sai Yok National Park, Lam Tam Keio, 10 Aug 1982, *Shimizu, T. et al. T.28519* (BKF, SING); Sangkhlaburi, 28 Jul 1968, *Prayad 1422* (BKF); Thong Pha Phum, 4 Jul 1973, *Maxwell, J.F. 73-107* (AAU, BK); Wang Pho, 26 Oct 1969, *Kasem 641* (BKF); Khon Kaen, Chum Phae, Phu Pha Man national park, Tham Pha Puang, 1 Aug 2011, *Norsaengsri, M. et al. 7965* (QBG); Khon Kaen, Nanong Tum, Ban Na Chan, 23 Aug 2011, *Norsaengsri, M. et al. 8048* (QBG); Khon Kaen, Pha Nok Khao, 9 Sep 1963, *Smitinand, T. & Sleumer, H.O. 1109* (K, L, SING). **Lampang:** Doi Pang La, Huay Tak, 25 Sep 1967, *Shimizu, T. et al. T.10789* (BKF); Muang Bahn, Chae Son, Jae Sawn Stream, 22 Aug 1995, *Maxwell, J.F. 95-536* (BKF, CMU, L); Ngao, Near Tham Pha Thai, 24 Sep 2008, *Middleton, D.J. et al. 4579* (E); Loei, Phu Kradung, 15 Oct 1967, *Prayad 1034* (BKF). **Loei:** Phu Ruea District, Phu Luang, 16 Sep 1966, *Phusomsaeng, S. & Bunchuai, K.* 42 (BKF, L). **Mae Hong Son:** Muang, Doi Pui, 23 Sep 1995, *Larsen, K. et al. 46861* (AAU); Mueang, Tham Pla-Namtok Pha Suea National Park, Pha Daeng Cave, 22 Aug 2013, *Norsaengsri, M. 10568* (QBG). **Nakhon Nayok:** Nang Rong Falls, 4 Aug 1992, *Larsen, K. et al. 43771* (P). **Nan:** Tham Pha Toop Forest Park, 2 Sep 1999, *Middleton, D.J. 149* (A, BKF, E, K); Muang, Tham Phatup Forest Park, 16 Aug 2012, *Middleton, D.J. et al. 5613* (E, SING); Muang Tam Paa Toop, 13 Sep 1995, *Nanakorn, W. 4240* (QBG); Tham Pha Tok, 25 Jul 1992, *Larsen, K. et al. 43589* (AAU); ibidem, 13 Sep 1995, *Larsen, K. et al. 46426* (AAU). **Phayao:** Doi Luang National Park, Champa Thong Waterfall, 9 Aug 1997, *Petrmitr, O. 70* (L). **Prachuap Khiri Khan:** Bang Saphan, Khao Maa Rong, 5 Sep 2008, *Middleton, D.J. et al. 4284* (E). **Phrae:** Nam Pu, 23 Sep 1912, *Van Pruk, L. 350* (BK, K). **Sa Kaeow:** Khao Chakan, 17 Oct 2010, *Staples, G.W. et al. 1409* (E, SING). **Saraburi:** Kaeng Khoi, Amata-khuha Cave, 20 Aug 2001, *Pooma, R. et al. 2100* (BKF); Kaeng Khoi, Tharn Pra Photisat, 7 Oct 1979, *Shimizu, T. et al. T.19413* (KYO, L); Muak Lek, 10 Nov 1924, *Marcan, A. 1869* (ABD, K); ibidem, 3 Sep 1928, *Put 1853* (K); Phraphutthabat, Wat Khaowong, 18 Sep 2004, *Pooma, R. et al. 4824* (E). **Surat Thani:** Kanchanadit, 31 Jul 1927, *Kerr, A.F.G. 13053* (K); Koh Samui, Kao Noi, 28 Jun 1966, *Sakol 1150* (BKF). **Tak:** Mae Sot, Doi Muser, 20 Aug

1961, *Chermsirivathana, C. 1* (BKF); Mae Sot, Khao Pha Wo, 23 Jul 1973, *Murata, G. et al. T.16922* (AAU, BKF, KYO, L); ibidem, 12 Oct 1979, *Shimizu, T. et al. T.18519* (KYO); Mae Sot, Wat Tham Inthanin, 11 Sep 2009, *Middleton, D.J. & Triboun, P. 4846* (E). **Tak:** Umphang, Takhobi Cave, 18 Oct 2014, *Middleton, D.J. et al. 5768* (BKF, E, SING). **Uthai Thani:** Lan Sak, Huppatat Non Hunting Area, 14 Oct 2014, *Middleton, D.J. et al. 5687* (BKF, E, SING).
CAMBODIA: **Kampot:** 20 Sep 1903, *Geoffray, M. 95* (P).
VIETNAM: **Lang Son:** Langnac, *Eberhardt 3363* (P).
PHILIPPINES: **Apayao:** May 1917, *Fenix, E. BS28106* (US). **Benguet:** Mt Trail, Oct 1929, *Quisumbing, E. BS78105* (NY); Twin Peaks, 8 Sep 1904, *Williams, R.S. 937* (NY). **Bukidnon:** Tanculan, Jul 1916, *Fenix, E. BS26049* (K, NY, US). **Bulacan:** 8 Sep 1935, *Bartlett, H.H. 14744* (GH). **Ilocos Norte:** Bangui, Nov 1923, *McGregor, R.C. BS43566* (K); Burgos, Jul 1918, *Ramos, M. BS32892* (GH, K, US). **Laguna:** Los Banos, *Loher, A. 1555* (K). **Oriental Mindoro:** Mansalay, Mt Yagaw, Nov 1952–Dec 1952, *Sulit, M.D. & Conklin, H.C. 16913* (L, PNH). **Pampanga:** Mt Arayat, Sep 1905, *Merrill, E.D. 4216* (K). **Rizal:** Aug 1911, *Ramos, M. BS13624* (BO, G, K, L, P, US). **Rizal:** Antipolo, Jul 1917, *Ramos, M. & Edaño, G. BS29466* (BO, P, US); Kay Ungulan, 18 Aug 1935, *Bartlett, H.H. 15380* (GH); Montalban, 11 Aug 1935, *Bartlett, H.H. 14487* (GH, PNH); ibidem, 3 Aug 1990, *Loher, A. 1556* (K); ibidem, Dec 1904, *Loher, A. 6669* (K); ibidem, Dec 1904, *Loher, A. 6668* (K, US); ibidem, 26 Sep 1890, *Loher, A. 1554* (K, P, US); ibidem, Nov 1909, *Merrill, E.D. 52* (G, US); ibidem, 2 Nov 1909, *Robinson, C.B. BS9534* (NY); ibidem, 2 Nov 1909, *Robinson, C.B. BS9525* (L, US); Morong, Aug 1906, *Ramos, M. BS1435* (NY, US).

Notes. Epithema ceylanicum is a widespread and variable species. The protologue of *Epithema ceylanicum* states the plants are hispidly pilose, have a persistent style and have five distinct nectaries. Only a proportion of the specimens from Sri Lanka are densely pubescent, only the basal section of the style is persistent and we have seen no more than two nectaries. As a variety Clarke (1883) separated *Epithema carnosum* var. *ceylanicum* (as "*zeylanica*") from *E. carnosum* var. *carnosum* on its larger calyx and seeds that are twice as large. However, neither of these characters holds up to closer scrutiny. Instead, it is easily distinguished from *Epithema carnosum* by the hooked rather than straight hairs on the operculum.

Rarely, it can be difficult to differentiate *Epithema ceylanicum* from *E. saxatile*, particularly as they both have hooked hairs on the ovary/operculum. They are most easily distinguished in the size of the bract which in *Epithema saxatile* usually encloses the inflorescence.

Epithema taiwanense was previously distinguished by the presence of many short, often fasciculate, peduncles with very small inflorescences and quite consistently rounded or rounded-acute leaf apices. However, these characters are within the overall range of variation of the very variable *Epithema ceylanicum* and we have, therefore, decided to synonymise the names and recognise a single species.

Some specimens bear a resemblance to *Epithema involucratum* but they can be distinguished by the presence of hair in the corolla and the usually numerous, small inflorescences among other characters. One of the specimens from the Philippines, *Fenix BS28106* (US), somewhat resembles *Epithema benthamii* in leaf shape but is, again, easily separated by having hooked hairs on the ovary/operculum rather than the straight hairs of *E. benthamii*.

One collection from the Philippines, *R.S. Williams 937* (NY(×2)), is rather distinct from most of the material of this species in the Philippines in its acaulescent habit and sessile upper leaves. It also has large bracts. None of these characters is unique in the species but the combination is unusual. Further collections are necessary to see whether this is distinct from *Epithema ceylanicum*.

Some collections of this species have strongly variegated leaves but this character does not appear to have any taxonomic significance.

4. *Epithema dolichopodum* Hilliard & B.L.Burtt, Edinburgh J. Bot. 54: 112 (1997). – TYPE: Malaysia, Sabah, Lahad Datu, Bukit Tempadong, 100–150 m, 11 June 1984, *Beaman, J.H. 10068* (holotype E; isotypes GH, K, L, MSC, NY, US). (Fig. 6)

Herb 7–28 cm tall, acaulescent with first leaves arising at ground level, sometimes with 1–2 additional elongated internodes, indumentum of vegetative organs sparsely to densely strigose and/or setose, hairs to 0.6 mm long; stem 2–6 mm wide with 0–2 nodes, internodes to 8 cm long. ***Leaves*** membranous to strongly membranous, petiolate, solitary, opposite one or more peduncles; petioles (1.5–)5–37 cm; blades 5–24 × 4–15.5 cm, cordate, broadly ovate or occasionally sub-spherical, symmetrical to barely asymmetrical, apex usually rounded, occasionally acute, base cordate or sub-truncate, occasionally sub-auriculate, inserted evenly on petiole or not, margin sub-entire to dentate and bidentate. ***Inflorescences*** 1–5 per plant; peduncles (2–)9–27 cm long, originating from the base of the plant or opposite solitary leaves; ***bracts*** pale green or green, cucullate but not always enclosing entire inflorescence, 10–25 × 6–14 mm, 1.2–2.5 times as long as wide, margin dentate; pedicels 2.1–4.6 mm long, sub-glabrous to densely pubescent, hairs minute and hooked. ***Calyx*** lobes purple or purple only at tips, 3.8–5.6 mm long; tube 2–4 × 1.5–3 mm, lobes triangular, 1.3–2.7 × 0.8–2 mm; minutely densely pubescent outside, hairs white; glabrous to very sparsely pubescent inside, hairs minute, in tips of lobes. ***Corolla*** tube white, lobes blue, with or without purple markings on lobes, 5–8.4 mm long; tube cylindrical, 3.3–6.3 × 1.3–3 mm, lobes 1.7–2.1 mm long, margin slightly fimbriate to fimbriate; band of villous hair inside. ***Stamen*** filaments 1 mm long; anther characters unknown; staminodes 1 mm long. ***Nectary*** of two discrete lobes, 0.4–1.5 × 0.8–1.7 mm, margin undulate. ***Ovary*** sub-cylindrical to sub-spherical, 0.8–1.3 × 0.6–1.3 mm, minutely pubescent on upper portion of ovary, medium to high density, hairs hooked, hyaline or white, 0.04–0.1 mm long; style 3.7–4.1 mm long, glabrous or rarely with minute, hooked hairs; stigma c. 0.5 mm wide. ***Fruit*** cylindrical to obovate, 2.3–3 × 2.1–2.5 mm; operculum 0.6–0.8 mm long, glabrous or as on ovary. ***Seed*** narrowly ovoid to ovoid, 0.3–0.6 × 0.1–0.2, dark brown, pattern partially spiralled or spiralled, regular.

Distribution. Malaysia (Sabah), Philippines (Palawan).

Habitat and ecology. Lithophytic on limestone. Found on boulders, outcrops, cave entrance walls in humid and shaded places at 90–150 m altitude. Flowering and fruiting in June, September–November.

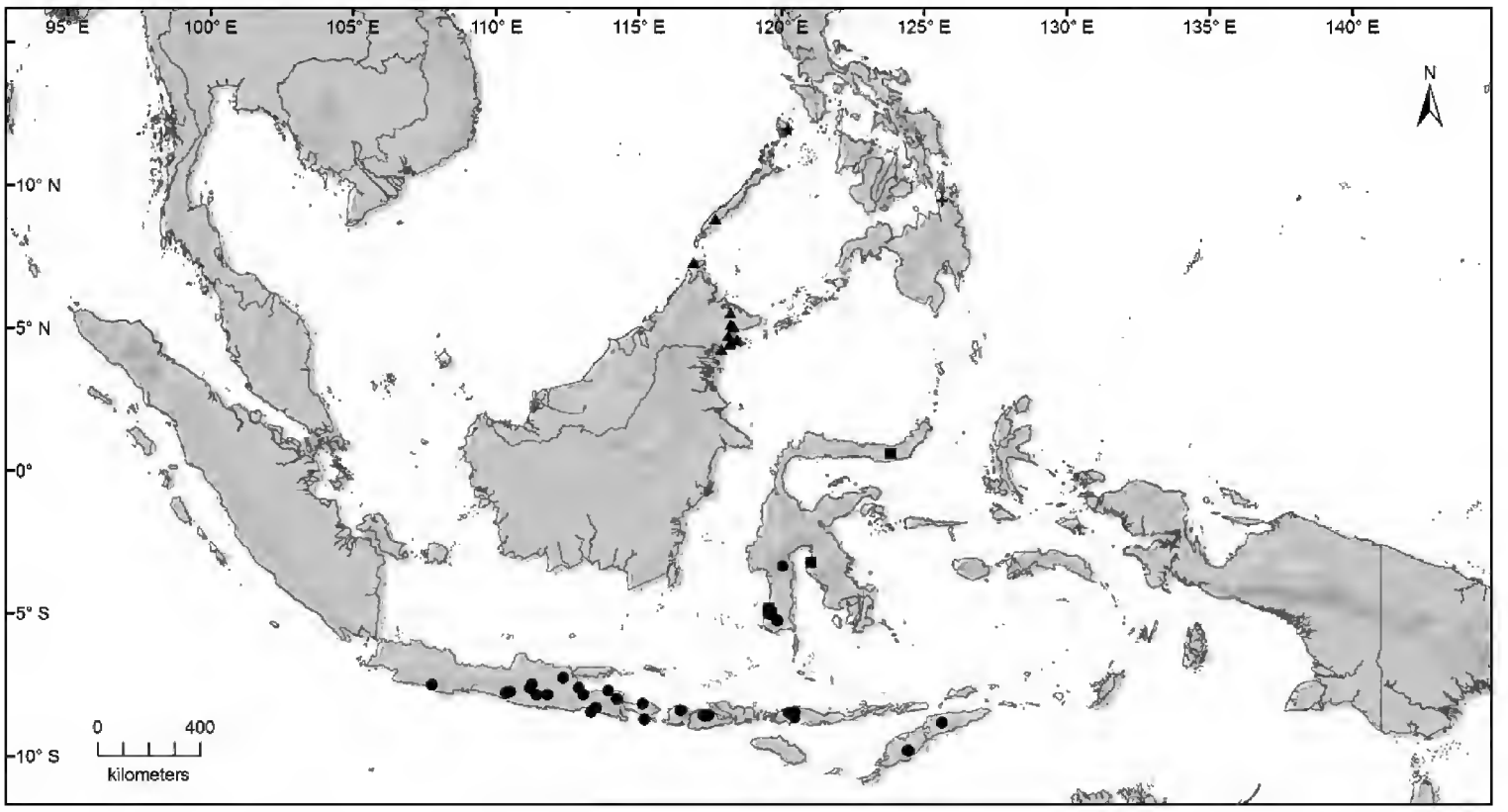

Fig. 6. Distribution of *Epithema dolichopodum* Hilliard & B.L.Burtt (▲), *Epithema horsfieldii* (R.Br.) DC. (●), *Epithema madulidii* Hilliard & B.L.Burtt (★), *Epithema philippinum* (Hilliard & B.L.Burtt) Bransgrove (+) and *Epithema tenerum* (C.B.Clarke) Hilliard & B.L.Burtt (■).

Provisional IUCN conservation assessment. Least Concern (LC). Although this species is not especially widespread, its distribution is not restricted enough to fall into the Vulnerable category under the B criteria if there were accompanying threats. However, as it frequently occurs on karst limestone, which is often commercially exploited, its status should be monitored.

Additional specimens examined. MALAYSIA: **Borneo: Sabah:** Hutan Simpan Madai, 15 Sep 1976, *Tamura, M. & Hotta, M. 690* (KYO); Kudat, Pulau Balembangan, Oct 1994, *Anthonysamy, S. et al. SB7* (E); Kudat, Pulau Balembangan, Kampung Sina, 9 Apr 1977, *Stone, B.C. & Anderson, E.F. SAN86719* (KLU); Kunak, Madai Hill, 9 Jun 1996, *Lim, S.P. et al. LSP681* (SING); ibidem, 9 Jun 1996, *Lim, S.P. et al. LSP675* (SING); Lahad Datu, Segama River, Batu Sarang, 25 Aug 1999, *Kiew, R. RK4759* (SING); Madai Baturong Forest Reserve, Madai Caves, 14 Nov 1968, *Kokawa, S. & Hotta, M. 1125* (KYO, L); ibidem, 14 Nov 1968, *Kokawa, S. & Hotta, M. 1073* (KYO); Segarong, *Kiew, R. et al. RK4321* (K, SING); ibidem, *Symington, C.F. & Agama, J. 9361* (K, SING); Sukau, Bod Tai, 14 Sep 1996, *Kiew, R. & Lim, S.P. RK4138* (K, SING); Tawao, Oct 1922–Mar 1923, *Elmer, A.D.E. 20569* (G, GH, K, L, SING); Tawau District, Mount Wullersdorf Forest Reserve, Teck Guan Quarry, *Nadiah, I. et al. SAN149136* (SING).
PHILIPPINES: **Palawan:** Mt Kabangaan, Apr 1929, *Edaño, G. BS77711* (GH); Mt Mantalingajan, Apr 1929, *Edaño, G. BS77570* (GH, SING).

Notes. This species is most easily confused with other acaulescent species such as *Epithema strigosum*, *E. longipetiolatum* and *E. rennellense*. One of the differentiating features of *Epithema dolichopodum* are the very long peduncles which are usually

(1–)2(–3) times the height of the rest of the plant. In *Epithema rennellense*, *E. longipetiolatum* and *E. strigosum* the peduncles are shorter to barely longer than the height of the plant. Other differences are discussed in the notes section of the other species.

The hairs on the ovary and operculum are hooked and minute, the only variation being the density of the hairs. While it is infrequent, the lower style may be pubescent with hooked hairs. Fruit with glabrous and pubescent styles were observed from the same plant.

While the upper surface of the leaves can be densely strigose, the surface of the leaves and the stem may appear glabrous due to the small size of the hairs.

The collections available for examination are from relatively few sites, four of which were in close proximity to each other.

To-date, the only other species of *Epithema* found in Sabah are *E. saxatile* and *E. sarawakense*.

5. *Epithema horsfieldii* (R.Br.) A.DC., Prod. 9: 279 (1845). – *Aikinia horsfieldii* R.Br., Pl. Asiat. Rar. 3: 66 (1932). – TYPE: Indonesia, Java, 1802–1818, *Horsfield, T. 85*, also labelled *Cyrtandr. 3* (lectotype BM [BM001125214], designated here; isolectotype K (×2)). (Fig. 6)

Epithema difformis Span., Linnaea 15: 331 (1841). – *Carpocalymna monophylla* Zipp. ex Span., Linnaea 15: 331 (1841), *nom. inval.* – TYPE: Indonesia, Timor, 1841, *Spanoghe, J.B. 57* (lectotype P, designated here; isolectotype L).

Epithema horsfieldii var. *epiphyllum* Hilliard & B.L.Burtt, Edinburgh J. Bot. 54: 112 (1997). – TYPE: Indonesia, Western Sumbawa, Batudulang and Sampar Olat Ranges, Mt Batulanteh, April 1961, *Kostermans, A.J.G.H. 18839* (holotype L; isotypes BO (image seen), K).

Herb 3.2–22 cm high, caulescent (but can appear as just one large leaf with the stem mistaken for a petiole), unifoliate or rarely with two leaves; stem 0.5–3.8 mm wide. ***Leaves*** sessile (but see above), membranous to strongly membranous; blade 3.2–17.5 × 2.4–13 cm, usually cordate or sub-cordate but also to oblong, symmetrical or not, apex broadly acute to rounded, base cordate to truncate, inserted evenly on petiole, margin entire to dentate, bidentate, serrate or crenate, arrangement of veins variable but the lower secondary veins often appearing to arise from around the base of the peduncles, often widely spaced, occasionally running down sides of midrib; upper surface pale green to green; lower surface light green or purplish. ***Inflorescences*** 1–15 per plant; peduncles 0.3–13.3 cm long, originating from the midrib at the base of the blade, or from the midrib up to 2.3 cm from the base; ***bracts*** cucullate, sub-cucullate or small and only enclosing a small proportion of the inflorescence, 2–22 × 3–12 mm, margin variable, irregularly dentate to dentate, occasionally lobed; pedicels 0.7–5 mm long. ***Calyx*** 2.5–5.7 mm long; tube 1–4.4 × 0.9–2.7 mm; lobes 0.6–5 × 0.4–2.3 mm;

glabrous inside or rarely sub-glabrous with hairs to 0.1 mm long. ***Corolla*** blue, lilac, lilac-blue, violet-purple and white in proximal half of the two upper lobes or violet only at tips, 6.5–12 mm long; tube cylindrical 4–9 × 0.9–2 mm; lobes 1.5–4.2 × 1 mm, margin undulate to slightly fimbriate; band of villous hair inside at one third to half way up the tube, occasionally the band is incomplete or the hair sparse. ***Stamens*** 0.7–1.9 mm long; filaments 0.6–1.7 mm long; anthers 0.3–0.6 mm long; staminodes 0.4–1 mm long. ***Nectary*** apparently absent or one or two lobes, sometimes encircling the ovary, margin entire or undulate and of variable height, 0.2–1.3 × 0.1–1.5 mm. ***Ovary*** sub-cylindrical to sub-spherical, 0.7–1.6 × 0.5–1.7 mm, sparsely to densely pubescent, hairs hooked to 0.1 mm long, on upper half of ovary or the uppermost portion of the ovary below the base of the style; style 0.5–5.8 mm long, glabrous to pubescent at the base, hairs hooked, 0.04–0.2 mm long; stigma 0.3–0.6 mm wide. ***Fruit*** obovate-cylindrical, shortly cylindrical or sub-spherical, 1.3–3 × 1–3 mm long; operculum 0.5–1 mm long, glabrous or pubescent in upper parts, hairs medium to high density, hooked, white, 0.04–0.13 mm long. ***Seed*** narrowly ovoid to ovoid, infrequently slightly sigmoid, ends acute or constricted, 0.3–0.6 × 0.1–0.2 mm, light to dark brown, pattern straight to spiralled and more or less regular.

Distribution. Indonesia (Java, Lesser Sunda Islands, Sulawesi), Timor Leste.

Habitat and ecology. Primarily lithophytic on limestone hills, rocks and cliffs, usually in shaded to heavily shaded areas. Also found in roadside cuttings. Collected at 40–900 m altitude. Flowering and fruiting January–May.

Provisional IUCN conservation assessment. Data Deficient (DD). Although this species is widespread and would normally be considered to be Least Concern there are surprisingly few recent collections from much of its range, particularly from Java. It is unclear whether this is due to a lack of collecting activity or whether it really has declined over much of its range. This will need to be investigated before a realistic conservation assessment can be made.

Additional specimens examined. INDONESIA: **Bali:** Singaraja, Gitgit Waterfall, 5 Apr 1936, *van Steenis, C.G.G.J. 7788* (BO); Gunung Kelatakan, 2 Aug 1918, *Maier Sarip, R. 162* (BO). **Java:** s.l., 8 May 1931, *Clason, E.W. C99* (L); *Zollinger, H. 2002* (S). **Jawa Timur:** Surabaya, Mantup, *Coster, C.* s.n. (BO); Gunung Wilis, 1914, *Backer, C.A.B. 11469* (BO); Besuki, Gunung Ringit, Kampong Agoeng, 8 Mar 1940, *Buwalda, P. 7542* (BO); Besuki, Jang Plateau, Djeloewang Ravine, 18 Jul 1938–19 Jul 1938, *van Steenis, C.G.G.J. 11079* (BO); Besuki, Puger, 28 Feb 1940, *Buwalda, P. 7225* (BO, L); Nusa Baron, 21 Feb 1845, *Zollinger, H. 2612* (BO); Pasuruan, 18 Mar 1929, *Backer, C.A.B. 36621* (L); Ponorogo to Soemoroto, Jan 1918, *Beumée, J.G.B. 1328* (BO); Soekapoera, Gorge of Oemboelan, 12 Apr 1925, *Jeswiet, J. 670* (WAG). **Jawa Tengah:** Gunung Lawoe, 1913, *Backer, C.A.B. 6607* (L); ibidem, 1913, *Backer, C.A.B. 6687* (BO); Yogyakarta, Gunung Kidoel, 1912, *Backer, C.A.B. 2789* (BO, L); Yogyakarta, *Unknown (ex Herb. Lugd. Batav.)* s.n. (L); Yogyakarta, Prambanan, Feb 1912, *Ridley, H.N.* s.n. (K). **Jawa Barat:** Pameungpeuk, Goenoeng Karikil, Jan 1933, *Jacobson, E. 199* (BO). **Nusa Tenggara Barat:** Lombok, Sambelia, Gunung Rinjani, 17 Feb 1998, *de Wilde,*

W.J.J.O. & de Wilde-Duyfjes, B.E.E. 21940 (E, L); ibidem, 2 May 1961, *Kostermans, A.J.G.H. 18629* (K, L); Western Sumbawa, Batudulang, Mt Batulante, 10 Apr 1961, *Kostermans, A.J.G.H. 18053B* (K); Western Sumbawa, Olat seli, Pernek, 17 May 1961, *Kuswata 213* (BO); Western Sumbawa, Sumbawa Besar, 29 Mar 2004, *Hoover, W.S. et al. Deden151* (US); Western Sumbawa, Sumbawa Besar, Semongkat Atas, 26 Mar 2004, *Hoover, W.S. et al. HW11417* (BO, US); ibidem, 1 May 1961, *Kuswata 105* (BO, L); ibidem, 2 May 1961, *Kuswata 121* (K, L). **Nusa Tenggara Timur:** Flores, *Loeters, J.J. 1625* (L); Flores, Lempe to Waewako, 26 Mar 1974, *Schmutz, E. 3623* (L); Flores, Waewako, 21 Feb 1978, *Schmutz, E. 4027* (L); Western Flores, Manggarai, 18 Feb 1979, *Schmutz, E. 4345* (L); ibidem, 6 Feb 1981, *Schmutz, E. 4732* (L); Timor, Naukae, 29 Jan 1971, *Kooy, C.W. 789* (L); Timor, Nikiniki, 20 Feb 1966, *Kooy, C.W. 403* (L). **Sulawesi Selatan:** Bulukumba, Malino, 2 Apr 1922, *Bünnemeijer, H.A.B. 10713* (BO, L); South ibidem, 8 Apr 1921, *Bünnemeijer, H.A.B. 10890* (BO); Bulukumba, Malino, Bulutana, 10 Feb 2000, *Mendum, M. et al. 0034* (E, SING); Maros, 23 Jan 1998, *de Wilde, W.J.J.O. & de Wilde-Duyfjes, B.E.E. 21918* (E, L).

Notes. Hilliard & Burtt (1997) described the variety *Epithema horsfieldii* var. *epiphyllum* which they distinguished from the type variety by the position of the inflorescences. In *Epithema horsfieldii* var. *horsfieldii* they usually arise from the base of the leaf blade and in *E. horsfieldii* var. *epiphyllum* from the midrib, up to 2.3 cm from the base of the blade. Occasionally the inflorescences of the plants placed in *Epithema horsfieldii* var. *horsfieldii* also arise from the lower midrib but these specimens are more densely villous inside the corolla than the material placed in *E. horsfieldii* var. *epiphyllum*. In addition the material assigned to *Epithema horsfieldii* var. *horsfieldii* is generally more pubescent than *E. horsfieldii* var. *epiphyllum* and has larger and more cucullate bracts. However, specimens with the morphology of the type variety were found disjunctly in Java and Timor and that of *Epithema horsfieldii* var. *epiphyllum* in Lombok, Sumbawa and Flores. This would be biogeographically unlikely. The material from Sulawesi is rather different again as much of the material has inflorescences arising in a slight groove at the base of the leaf blade which is not found in the two existing varieties whereas other specimens are more similar to the type variety. What is clear is that the patterns of variation require considerably more study and that if varieties are to be recognised they should only be so after more collecting from throughout the range of the species (but particularly in Timor) and after a more thorough understanding of the variation.

6. *Epithema involucratum* (Roxb.) B.L.Burtt, Notes Roy. Bot. Gard. Edinburgh 22: 308 (1958). – *Gratiola involucrata* Roxb., [Hort. Bengal. 80 (1810), nom. nud.] Fl. Indica ed. 1, 138 (1820). – *Epithema roxburghii* A.DC., Prod. 9: 279. (1845), nom. superfl. – TYPE: "Moluccas", *Roxburgh s.n.* (lectotype PDA, designated here). (Fig. 7)

Aikinia brunonis Wall., Pl. Asiat. Rar. 3: 66 (1832); G.Don, Gen. Hist. 4: 665 (1838). – *Epithema brunonis* (Wall.) Decne., Nouv. Ann. Mus. Hist. Nat. 3: 404 (1834); Decne., Herbarii Timorensis Descriptio 76 (1835); A.DC., Prodr. 9: 279 (1845); Clarke in

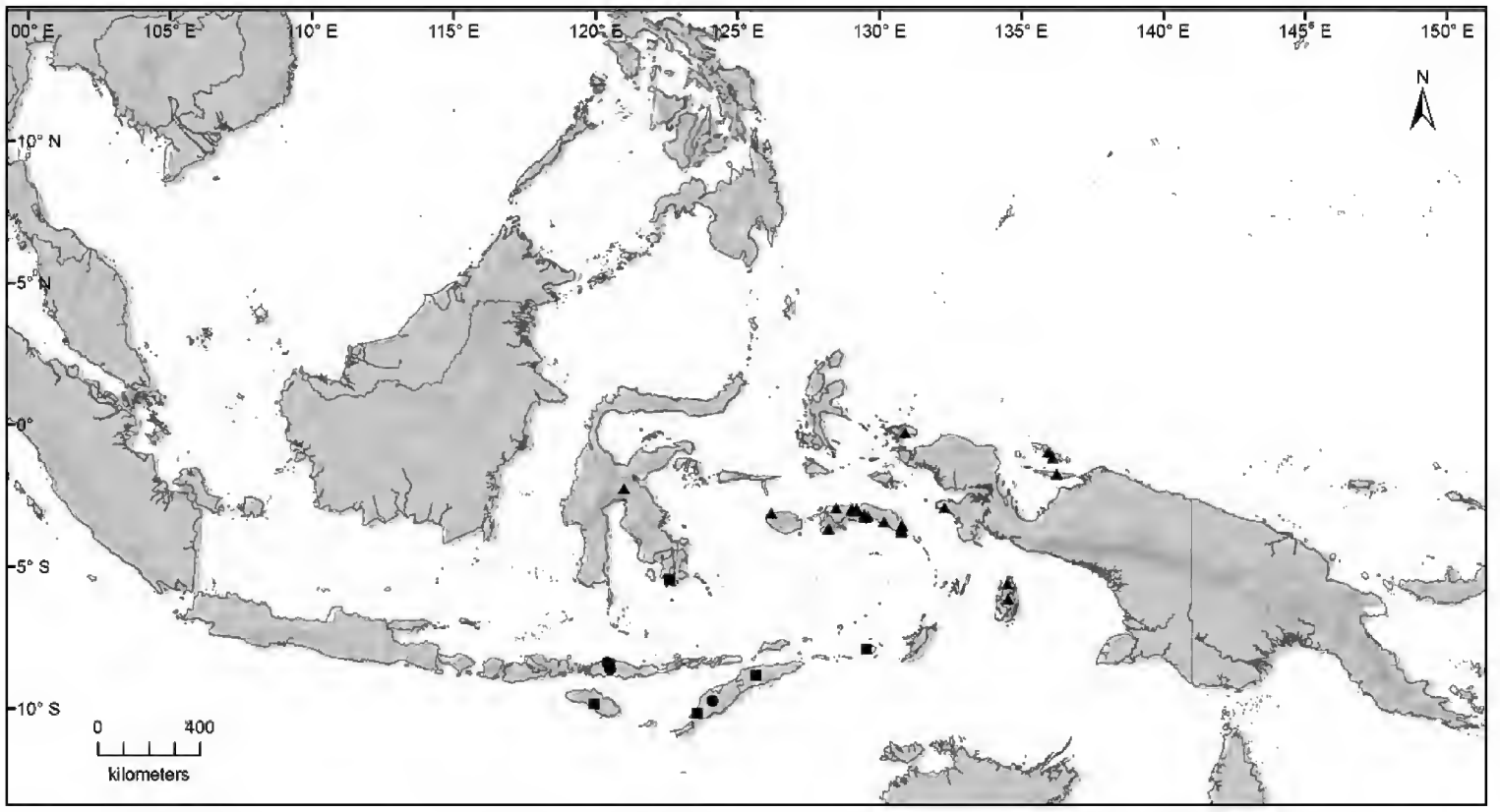

Fig. 7. Distribution of *Epithema involucratum* (Roxb.) B.L.Burtt (■), *Epithema longipetiolatum* (Merr.) Hilliard & B.L.Burtt (▲), *Epithema longitubum* Hilliard & B.L.Burtt (●).

A.DC. & C.DC., Monogr. Phan. 5(1): 179 (1883). – TYPE: Indonesia, East Nusa Tenggara, Timor, Coepang, Apr 1803, *Brown, R. s.n.* (lectotype BM, designated here).

Epithema brunonis var. *violaceum* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 179 (1883). – *Epithema violaceum* Span., Linnaea 15: 330 (1841), *nom. nud.* – TYPE: Timor Leste, *Spanoghe 58* (holotype P; isotype L).

Herb 4.5–20 cm high, caulescent, indumentum strigose to hispid, hairs sparse to medium density, to 0.3 mm long on the stem, petioles, peduncles, lower bract, and the outside of the calyx, to 0.8 mm long on the upper and lower surface of the leaves, indumentum of lower bract, pedicels and the outside of the calyx also of minute hairs; stem 1–3 mm wide with 2 to 3 nodes, internodes 1.3–3 cm long. ***Leaves*** membranous and petiolate, upper leaves opposite; petioles 0.2–4.5 cm long; blades 1.3–6 × 1–5.4 cm, ovate or cordate, rarely almost oblong symmetrical or barely asymmetrical, apex rounded to truncate, more rarely broadly acute, base cordate or truncate, inserted evenly on petiole or not, margin entire or with few, minute teeth, undulate. ***Inflorescences*** up to 5 per plant, terminal, in lower leaf axils or on base of petioles; peduncles 1.3–5.5 cm long; ***bracts*** cucullate but not always enclosing entire inflorescence, 7–17 × 4–10 mm, margin variable, almost entire to dentate, upper surface sub-glabrous, hairs to 0.2 mm long, placed primarily towards margins of the bract; pedicels 0.9–3.5 mm long, indumentum may include strigose hairs to 0.5 mm long. ***Calyx*** 2.9–4.4 mm long, tube 1.7–2.5 × 1–2.5 mm, lobes 1–2.1 × 0.6–1.9 mm; glabrous inside. ***Corolla*** light blue or bluish to dark violet, tube may be white, 9–11 mm long; tube 5–6 × 1.5–2 mm; lobes 4–5 × 3–4 mm, almost as long as the tube; glabrous outside and inside. ***Stamen***

filaments 1.2 mm long; anther dimensions unknown; staminodes 0.7 mm long. ***Nectary*** of two discrete lobes, 0.6 × 0.6 mm. ***Ovary*** cylindrical or sub-cylindrical, 0.8–1 × 0.7 mm, pubescent, hairs dense, hooked, white, to 0.1 mm long on upper portion of ovary; style 3.5 mm long, glabrous or sub-glabrous, hairs, when present, hooked and on lower style; stigma to 0.5 mm wide. ***Fruit*** sub-cylindrical to sub-spherical, 1.7–1.9 × 1.7 mm; operculum 0.6–0.8 mm long, sparsely to densely pubescent, hairs hooked, to 0.1 mm long, on entire operculum. ***Seed*** fusiform to broadly oval, 0.3–0.5 × 0.1–0.2 mm; pattern straight to spiralled and even.

Distribution. Indonesia (Sulawesi, Timor, Maluku), Timor Leste.

Habitat and ecology. In shaded areas. Highly likely to be lithophytic on limestone and found in humid places and/or near water.

Provisional IUCN conservation assessment. Data Deficient (DD). The known localities of this species suggest a fairly widespread distribution. However, it has not been collected often, many of the collections are fairly old and the exact localities of some of these older specimens are not known. We, therefore, assign it the status of Data Deficient until more information becomes available.

Additional specimens examined. INDONESIA: **Maluku:** Babar Islands, Pulau Weten, 28 Feb 1956, *van Borssum Waalkes, J. 3025* (BO, L). **Nusa Tenggara Timur:** Sumba, Laora, 10 Nov 1925, *Iboet 221* (BO); Timor, *Spanoghe, J.B. 226* (L); ibidem, *Unknown (probably Spanoghe) 226* (L). **Sulawesi Tenggarah:** Pulau Butung, Baoe Baoe, 20 Feb 1929, *Kjellberg, G.K. 314* (BO, S); ibidem, 20 Feb 1929, *Kjellberg, G.K. 315* (S).

*Notes.*The key macroscopic features distinguishing *Epithema involucratum* from other species are the cordate to ovate leaves with clearly rounded leaf tips and that it is one of the few species that is glabrous inside the corolla. *Epithema longitubum* and some specimens of *E. ceylanicum* are similar to *E. involucratum*. The *Epithema ceylanicum* specimens can be distinguished from *E. involucratum* by the presence of an indumentum inside the corolla, smaller inflorescences and shorter corolla length. *Epithema longitubum* can be distinguished by the often longer corolla length and presence of an indumentum in the corolla. While there were not many corollas available to examine, it would seem that the lobes of *E. involucratum* are quite large in comparison to other species.

Van Borssum Waalkes 3025 (L) from Maluku is rather intermediate between *Epithema involucratum* and *E. longitubum*. It is included in *Epithema involucratum* on the basis of its leaf shape, absence of hair in the corolla and the lack of an upper, solitary leaf. It does have medium to high density, strigose hairs on the inner side of the calyx lobes which is unusual for either species. Its inclusion in *Epithema involucratum* significantly extends the known distribution of *E. involucratum*, as it would also have done for *E. longitubum* if it were included there.

Kjellberg 314 (S) from Sulawesi also extends the range of *Epithema involucratum* although, while most of its characters are typical for *E. involucratum*, it has hooked hairs at medium density on the ovary which is unusual for this species.

Epithema brunonis var. *violaceum* is included in synonymy of *E. involucratum*. Clarke (1883) used depth of flower colour, length of the corolla and the leaf pubescence to delineate it from the type variety. The flower colour and leaf pubescence is not different from that seen in other *E. involucratum* specimens and the corolla length, from material that Clarke himself examined, is 9 mm not 12 mm as Clarke stated when differentiating the variety. The key differences are nominal; the shape of the base of a couple of leaves differ slightly and the peduncles can be up to 15 mm longer than in typical *E. involucratum*. *Epithema brunonis* var. *violaceum*, however, is within the range of variation for *E. involucratum*.

In the protologue of *Aikinia brunonis* there is no indication of a collector of the specimen used to make the description, only that it is based on a collection from Coepang (now called Kupang) in Timor which was flowering and fruiting in April 1803. There is a Robert Brown collection from Coepang collected in April 1803 in the BM. This specimen is lectotypified here.

7. *Epithema longipetiolatum* (Merr.) Hilliard & B.L.Burtt, Edinburgh J. Bot. 54: 112 (1997). – *Epithema brunonis* var. *longipetiolatum* Merr., Philipp. Journ. Sci., C. 11: 313 (1916). – TYPE: Indonesia, Maluku, Ambon, Halong, 50–100 m, 26 September 1913, *Robinson, C.B. 1727* (lectotype L, designated here; isolectotypes BO, K, US). (Fig. 7)

Herb 5–30 cm high, acaulescent or caulescent; stem 2–3 mm wide with two nodes, internodes 7–10 cm long. ***Leaves*** membranous, petiolate, usually solitary but upper leaves may be opposite, opposite leaves are occasionally unequal in size; petioles (0–)0.5–12(–18) cm; blade 3–13.6 × 2.4–10.2 cm, cordate to broadly ovate or occasionally sub-lanceolate, symmetrical or asymmetrical, apex acute, base sub-cordate or sub-auriculate to cuneate, inserted evenly on petiole or distinctly offset, margin almost entire to serrulate or denticulate, veins often widely spaced; upper surface glabrous or sparsely to densely strigose, hairs to 0.4 mm long, with or without a minute hooked pubescence; lower surface finely pubescent, at medium to high density, surface often appearing fuzzy. ***Inflorescences*** 1–6 per plant; peduncles 0.2–6 cm long, terminal or in the axils of upper leaves; ***bracts*** cucullate but not enclosing the entire inflorescence, 5–12 × 4–9 mm, margin somewhat dentate to dentate and serrate, upper surface sub-glabrous to sparsely strigose, hairs straight, to 0.2 mm long, denser towards the margin; pedicels 1–4.2 mm long. ***Calyx*** 2.7–5.6 mm long; tube 1.5–5 × 1.5–3.8 mm, lobes 1.2–2.7 × 0.6–1.7 mm; minutely pubescent (often finely) outside, occasionally strigose, at medium to high density, all hairs hooked or primarily hooked and to 0.25 mm long, hairs on inside of lobe tips to 0.13 mm, occasionally sub-glabrous. ***Corolla*** tube white, lobes lilac or pale lilac, lobes with darker coloured but variable markings, 5.5–10.2 mm long; tube cylindrical, 4.2–6.4 × 1.5–1.9 mm, lobes 1.2–3.8 mm long; with a band of villous hairs inside around middle, up to 1 mm wide. ***Stamens*** 2.1–3.1 mm long; filaments 1.5–2.3 mm long; anthers 0.6–0.8 mm long; staminodes 1.2–2.3 mm long. ***Nectary*** of two discrete lobes, margin entire or undulate, 0.5–1.1 × 0.7–1.7

mm. ***Ovary*** sub-cylindrical or sub-spherical, 1–1.5 × 0.7–1.3 mm, densely pilose, hairs usually straight or occasionally straight and hooked, placed on upper portion of ovary, 0.04–0.08(–0.25) mm long; style 3.1–4.4 mm long, wider at base to 0.33 mm, style glabrous or with very few hairs at base, these straight, to 0.17 mm long; stigma 0.4 mm wide. ***Fruit*** obovate to sub-cylindrical, 2–4 × 2–3.5 mm; operculum 0.6–1.9 mm, finely setose or pilose, hairs medium to high density, as on ovary. ***Seed*** narrowly to broadly ovoid, 0.3–0.5 × 0.1–0.2 mm, light to medium brown, pattern straight to partially spiralled, often with thick, clearly defined walls.

Distribution. Indonesia (Ambon, Buru, Seram, Aru, Sulawesi, Papua).

Habitat and ecology. Lithophytic on limestone. In humid, shaded places, often on rocks in stream beds at 0–1770 m altitude. Flowering and fruiting throughout the year.

Provisional IUCN conservation assessment. Least Concern (LC). This species is widespread. However, as it frequently occurs on karst limestone, which is often commercially exploited, its status should be monitored.

Additional specimens examined. INDONESIA: **Maluku:** Aru Islands, Pulau Kobroor, Namadoeboele, 10 Jun 1938, *Buwalda, P. 5202* (BO); Aru Islands, Pulau Wokam, Dosinamalaoe, 1 Jun 1938, *Buwalda, P. 5110* (A, BO, K, L); Buru, NW Buru, Bara, 5 Dec 1984, *van Balgooy, M.M.J. 5066* (BO, L); Buru, NW Buru, Bara, Waeduna River, *Nooteboom, H.P. 5217* (L); ibidem, 25 Nov 1984, *van Balgooy, M.M.J. 4889* (E, L); Ambon, *Boerlage, J.G. 528* (BO); ibidem, *Teijsmann, J.E.* s.n. (BO); Seram, 9 Jan 1938, *Eyma, P.J. 2574* (BO, L); Seram, Kampong Kwaos, Gunung Toenlean, 8 Sep 1938, *Buwalda, P. 6006* (K, L); Seram, Kampong Selagor, Gunung Selagor, 26 Aug 1938, *Buwalda, P. 5748* (BO, L); Seram, Kecamatan Seram Utara, Goa Pohon Damar to Gunung Roihelu, 24 Jan 1985, *Kato, M. et al. C.5232* (L); Seram, Kecamatan Seram Utara, Goa Pohon Damar to Sawai, 27 Jan 1985, *Kato, M. et al. C.5728* (L); Seram, Pileana, 28 Oct 1937, *Eyma, P.J. 1826* (A, BO, K, L, SING); Seram, 4 Feb 1918, *Kornassi 967* (BO, L); Seram, Manusela National Park, Gunung Binaia, 26 Aug 1987, *Argent, G.C.G. C8754a* (E); Seram, Tehoru, Hatumete Pass, 29 Nov 1917, *Kornassi 621* (BO, L); Seram, Tehoru, Saunulu, Murkele Ridge, 21 Jul 1986, *Kato, M. et al. C.11441* (L); ibidem, 21 Feb 1985, *Kato, M. et al. C.5144* (L); Seram, Taniwel, Between Buria and Wae Mala, 3 Feb 1985, *Kato, M. et al. C.6007* (A, L). **Papua Barat:** Kabupaten Raja Ampat, Waigeo Island, Tuluk Mayalipit, Warsamdin, 1 May 2008, *Okada, H. & Tsukaya, H. OT-48* (BO); Biak, *Aet & Idjan 942* (BO, L); Biak, Gunung Wawah, 22 Jul 1939, *Aet & Idjan 32* (A, BO, K, L); Fak-Fak, Fak-Fak River, 23 Feb 1962, *Vink, W. BW12141* (L). **Sulawesi Tengah:** Soroako, Mt. Wawonseru, 2 Jul 1979, *Hennipman, E. 610g* (A, E, L).

Notes. The specimens of *Epithema longipetiolatum* with leaves arising from ground level could be confused with *E. rennellense* and *E. strigosum* although there is no overlap in distribution. Leaves arising from ground level are always present in *E. rennellense* and *E. strigosum* and opposite leaves are never seen in these species. The leaf margin of *Epithema strigosum* has large wide teeth (entire to weakly dentate in *E. longipetiolatum*). *Epithema rennellense* has straight and hooked hairs on the ovary and operculum (usually only straight in *E. longipetiolatum*).

'Longipetiolatum' refers as much to the length of the secondary internode as to the petioles, giving the plant an elongate appearance. For example, in *Kornassi 967* (L), the secondary internodes are a third of the total plant height and equal to the primary internode and the upper petiole and blade combined.

Epithema longipetiolatum may have solitary leaves only, opposite leaves only, or opposite and solitary leaves. This does not correlate with geography and both types can be found within a population. For example, duplicates of the type collection have only opposite leaves or only solitary leaves while *Argent C8754a* (E) from Seram includes plants that have only opposite leaves or both opposite and solitary leaves.

Some specimens of *Epithema longipetiolatum* are similar to specimens of *E. benthamii*. For example, one duplicate of *Eyma 1826* (L), from Seram, has a similar leaf shape and margin to *E. benthamii*. We have seen no specimens of *Epithema benthamii* from Seram, but *E. longipetiolatum* and *E. benthamii* are found in the same locality in the Waeduna River district on Buru Island. The ovary and operculum hair of specimens of *Epithema longipetiolatum* found on Buru Island often have a mixture of long (to 0.25 mm), almost villous hairs that are straight or straight and hooked like *E. benthamii*, in addition to the expected, short hairs. This contrasts with the type specimen of *Epithema longipetiolatum* from Ambon, the *E. longipetiolatum* specimens from Seram, Wokam Island and the *Aet & Idjan 942* (L) specimen from Biak in West Papua, which have minute, pilose, straight hairs (rarely with a few hooked hairs) on the ovary and operculum. It is possible some hybridisation occurs between *Epithema longipetiolatum* and *E. benthamii* in these localities.

The minute hooked pubescence on the pedicels and outer calyx is quite distinctive, especially for the specimens from Seram. For most specimens of *Epithema longipetiolatum*, the indumentum of the upper leaf surface is of long, strigose hairs and looks somewhat like the indumentum of the upper surface of the leaves of *E. benthamii*. Specimens from Buru, however, have a dense, uniform and short indumentum, giving the leaves a fuzzy look.

8. *Epithema longitubum* Hilliard & B.L.Burtt, Edinburgh J. Bot. 54: 112 (1997). – TYPE: Timor, Nasinutan, 11 March 1939, *Bloembergen, S. 3458* (holotype L; isotype BO (image seen)). (Fig. 7)

Herb 7.5–20 cm high, with a distinct (but sometimes short) stem before first leaf; stem 0.6–2.5 mm wide with two nodes, internodes 1.5–7 cm long. ***Leaves*** membranous, petiolate, upper leaves opposite or with an uppermost leaf solitary opposite a peduncle; petiole of lowest leaf 4–6 cm long, petioles of upper leaves 0.5–5.5 cm; blade 1.7–11 × 1–7.8 cm, sub-orbicular to broadly ovate or somewhat oblong, symmetrical or not, if not one side up to 1.3 times wider than the other, apex rounded to acute, base shallowly auriculate or cordate to rounded, inserted evenly on the petiole or not, margin almost entire to serrulate or denticulate, venation sub-opposite towards base, usually alternate towards leaf tip, widely spaced; upper surface with a longer indumentum of hairs to 1 mm long, with or without an additional shorter pubescence of hooked hairs; lower

surface drying pale, indumentum as upper surface but less dense. ***Inflorescences*** 2–10 per plant; peduncles 0.5–8 cm long, terminal or in leaf axils; ***bracts*** diamond-shaped or trullate, cucullate but only enclosing a small portion of the inflorescence, 2–9 × 3–6 mm, margin roughly entire with occasional dentation or with some crenate and dentate lobes, indumentum of lower surface variable with hairs to 0.5 mm long; upper surface sub-glabrous, sparsely and minutely pubescent or sparsely strigose; pedicels 0.75–4.2 mm long. ***Calyx*** 2.9–5.2(–7) mm long; tube 1.4–4.2 × 1.3–2.5 mm; lobes 1–2.9 × 0.4–1.3 mm; minutely and sparsely to densely pubescent outside and with or without larger hairs to 0.7 mm long at medium to high density throughout calyx or largely on lobes; glabrous to sparsely and minutely pubescent inside on upper part of lobes. ***Corolla*** blue-purple, c.10–17 mm long; tube cylindrical, 8–12 × 1.3–2 mm, up to 7 times as long as wide; lobes 2–5 mm long; with band of villous hair inside in lower part. ***Stamens*** 1.8–2.3 mm long; filaments 1–1.5 mm long; anthers 0.8 mm long; staminodes 0.6–1.4 mm long. ***Nectary*** of one or two lobes, partly to entirely encircling ovary, 0.5–0.9 × 1.3–1.5 mm, margin undulate and of varying height. ***Ovary*** sub-cylindrical or broadly ovoid with a truncate base, 0.9–1.1 × 0.4–0.6 mm, densely pubescent on upper portion, hairs hooked; style 8.8–10 mm long, glabrous, rarely with few hooked hairs at base. ***Fruit*** sub-spherical to cylindrical, 1.3–2.5 × 1.7–2 mm; operculum 0.5–0.6 mm, pubescent throughout but denser at top, hairs hooked, to 0.08 mm long. ***Seed*** ovoid to broadly ovoid, 0.3–0.5 × 0.1–0.2 mm, pattern partially spiralled to spiralled, regular.

Distribution. Indonesia (Timor, Flores).

Habitat and ecology. Lithophytic on limestone in humid, shady places near or beside streams and cave entrances at 900–1200 m altitude. Flowering and fruiting March and May.

Provisional IUCN conservation assessment. Data Deficient (DD). The most recent collection of this species is from 1974 and the collection density on both Flores and Timor is too low to have an accurate idea of the current distribution.

Additional specimens examined. INDONESIA: **Nusa Tenggara Timur:** Flores, 25 Mar 1972, *Verheijen, J.A.J. 3070* (L); ibidem, Mar 1974, *Verheijen, J.A.J. 3323* (L); Flores, Ruteng-Mano, 16 May 1973, *Schmutz, E.3208* (L); Flores, Ruteng-Reo, 7 Mar 1968, *Schmutz, E.2127* (L); Timor, 30 Jan 1929, *Walsh, M.E. 62* (BO); Timor, Nasinutan, 17 Mar 1939, *Bloembergen, S. 3496* (BO, L).

Notes. This species is most similar to *Epithema involucratum* but the inflorescences, bract and corollas are usually much larger. Unfortunately the locality information on specimens of both *Epithema longitubum* and *E. involucratum* is poor and, therefore, it is as yet unclear whether these two species co-occur or not without further field work.

Although nectary characters have not proven useful in *Epithema*, and relatively few specimens have been examined for this species, it is interesting to note that the

specimens from Flores have two nectary lobes and the specimen from Timor has one. The sampling density, however, is currently too low to make any firm conclusions.

9. *Epithema madulidii* Hilliard & B.L.Burtt, Edinburgh J. Bot. 54: 112 (1997). – TYPE: Philippines, Coron Island, Banol, 30 Sep 1993, *Madulid, D.A., Agoo, Reynoso & Fuentes, R. 11563* (holotype PNH; isotype E). (Fig. 6)

Herb 13.2–50 cm high, caulescent; stem 1–4.2 mm wide with two nodes, internodes 1.5–11 cm long. ***Leaves*** membranous or strongly membranous, lower leaf petiolate, upper leaves sessile; lower petioles 1–10 cm long, sparsely to densely hairy, often with two distinct lengths of hair, hairs white, to 1.1 mm long; lower leaf blade 9–13 × 4.2–7.2 cm, upper leaves 2–4.5 × 1.7–3.5 cm, lower leaf cordate to ovate, base cordate to rounded, upper leaves ovate to elliptic, all leaves usually asymmetrical, one side 1.1–1.8 times wider than the other, apex broadly acute to rarely rounded, base cordate to obtuse, margin sub-entire to sinuate to minutely dentate, inserted evenly on petiole or not; upper surface sparsely to densely hairy, often with two distinct lengths of hair, hairs to 0.4 mm long; lower surface similar, hairs to 0.5 mm long, indumentum on veins often white and to 0.8 mm long. ***Inflorescences*** 1–3 per plant, terminal; peduncles 1.4–8 cm long; ***bracts*** whitish at base, upper half violet, cucullate, partially enclosing inflorescence, 10–25 × 6–15 mm, margin dentate to irregularly dentate, lower surface sub-glabrous or sparsely strigose, upper surface glabrous; pedicels 1–4.2 mm long. ***Calyx*** 6.3–7 mm long; tube 3–5.2 × 2.1–3.8 mm, often drying a lighter colour than the lobes; lobes 1.5–2.9 × 1.1–3.8 mm, outside glabrous or with sparse hairs primarily on lobes, hairs to 0.6 mm long; sub-glabrous or pubescent inside, hairs straight, to 0.1 mm long, mostly only in lobes, occasionally in the tube. ***Corolla*** violet at tips, 5–10.4 mm long; tube cylindrical, 3.3–6.5 × 1.5–1.8 mm; lobes 1.7–4.5 mm long; sub-glabrous to pubescent on lobes outside, hairs hooked or straight, glabrous inside. ***Stamens*** 1.3–1.5 mm long; filaments 0.6–0.7 mm long; anthers 0.7–0.8 mm long; staminodes 0.6–0.75 mm. ***Nectary*** of one lobe, encircling half to two-thirds of the ovary, 0.5–0.9 mm high, margin entire or almost entire. ***Ovary*** sub-spherical, 0.7–1.1 × 0.5–0.8 mm, densely pubescent on upper portion of ovary, hairs hooked, white, to 0.04 mm long; style 6.3 mm long, glabrous or occasionally with few straight hairs. ***Fruit*** obovate to obovate-cylindrical, 2.6–4 × 2–2.7 mm; operculum 0.6–0.9 mm, sub-glabrous to densely pubescent, hairs straight and hooked, to 0.13 mm long. ***Seed*** ovoid or with one side flattened, 0.5–0.6 × 0.1–0.2 mm, medium to dark brown, pattern more or less straight to spiralled, regular, lines of pattern thickened.

Distribution. Philippines (Coron Island).

Habitat and ecology. Found in shallow soil in limestone rock crevices in humid, shaded areas at c. 50–550 m.

Provisional IUCN conservation assessment. Data Deficient (DD). This species is only known from two collections from Coron Island and has both an EOO and AOO that

would put it in the Critically Endangered category. However, this limestone island and neighbouring islands are not well collected and the impact of tourism on the habitat is not clear.

Additional specimen examined. PHILIPPINES: **Palawan:** Coron Island, Sep 1922, *Lopez, G. BS41343* (BO, K, L, P, US).

Notes. This species is known from two collections from Coron Island collected in 1922 and 1993. Due to the poor condition of the specimens, particularly the *Lopez BS41343* collection, some information such as leaf blade, base and tip shape is assessed from very few leaves.

The calyx of this species is quite large and the tube dries a very light brown colour in comparison to the lobes although this is based on a very small sample. The corolla tube is glabrous, or appears so, and, in combination with the light colour and large size of the calyx, is useful for identification from dried specimens. It is similar to the sessile-leaved form of *Epithema saxatile* but can be distinguished by the complete lack of hair inside the corolla and the presence of straight hairs on the operculum. In addition the calyx is larger (6.3–7 mm versus 3.3–5 mm) and there are hairs on the inside of the calyx lobes (lacking in *Epithema saxatile*).

10. ***Epithema membranaceum*** (King) Kiew, Malayan Naturalist J. 38(3): 36 (1985); B.L.Burtt, Thai For. Bull. (Bot.) 29: 93 (2001). – *Argostemma membranaceum* King, J. Asiat. Soc. Bengal, Pt. 2, 72: 145 (1903); Ridley, Fl. Malay Penins. 2: 24 (1923). – TYPE: Malaysia, Penang, Muka Head, *Curtis 955* (lectotype SING, designated by Kiew (1985)). (Fig. 8, 9)

Herb 10–30 cm high, caulescent, indumentum of minute hooked pubescence and strigose hairs, usually sub-glabrous or sparse; stem 1.5 mm wide, can be red-brown in colour, with 2–3 nodes, internodes 0.6–12 cm long. ***Leaves*** often finely membranous, petiolate, upper leaves opposite, infrequently upper leaves solitary or sub-opposite; petioles 0.8–14.5 cm long; blade 3.6–11.5 × 3–10.5 cm, broadly ovate or cordate, occasionally sub-orbicular or almost oblong, symmetrical or barely asymmetrical, apex acute to rounded, upper portion of leaf sometimes curved, base sub-auriculate to truncate, inserted evenly on petiole, margin entire to serrate, crenate or with large, rounded dentation; upper surface glabrous to sparsely strigose (occasionally to medium density), hairs to 0.6 mm long; lower surface glabrous, sub-glabrous or covered in dense, minute hooked pubescence, giving a fuzzy appearance. ***Inflorescences*** (1–)3–9 per plant; peduncles 0.5–17 cm long, primarily from terminal leaf axils, rarely from the base of the petioles; ***bracts*** usually small, obovate, ovate or elliptic, not enclosing inflorescence, if sub-cucullate then only enclosing a small proportion of the inflorescence, 2–11 × 3–12 mm, margin entire or with limited dentation, lower surface sub-glabrous, upper surface glabrous or with sparse hair towards bract margin; pedicels 1–3.5 mm long, densely and minutely pubescent, with or without few additional straight, strigose hairs to 0.3 mm long. ***Calyx*** 2.1–5.2 mm long; tube

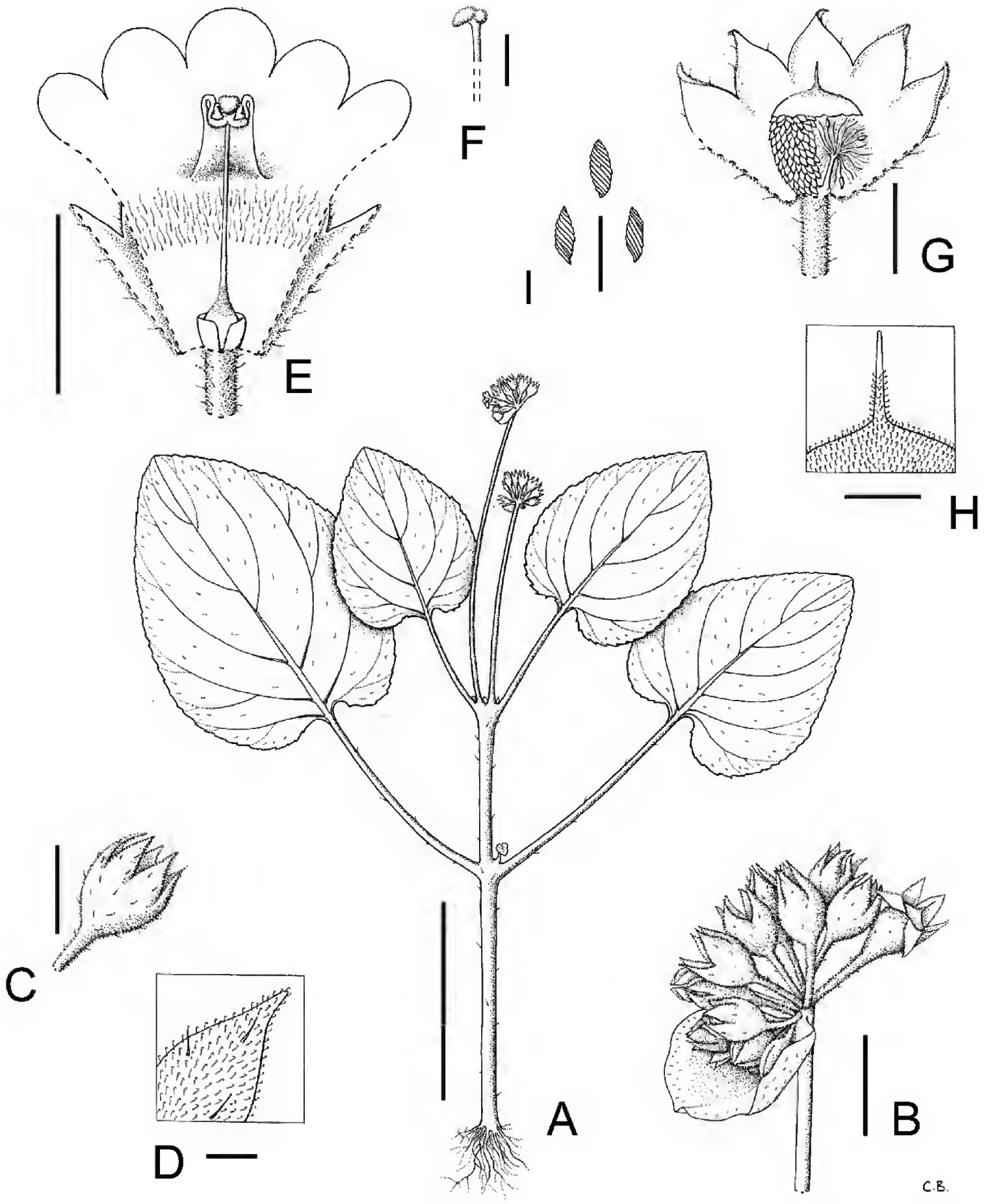

Fig. 8. *Epithema membranaceum* (King) Kiew **A.** Habit. **B.** Inflorescence. **C.** Calyx. **D.** Calyx indumentum detail. **E.** Flower opened out. **F.** Stigma lateral view. **G.** Fruit showing seeds, placenta and operculum. **H.** Operculum indumentum. **I.** Seeds. Scale bars: A = 4 cm, B = 5 mm, C = 3 mm, D, H, I = 0.5 mm, E = 4 mm, F = 1 mm, G = 2 mm. Drawn by Claire Banks from *Larsen et al 42245* (A–D, G–I) and *Larsen et al. 42312* (E, F).

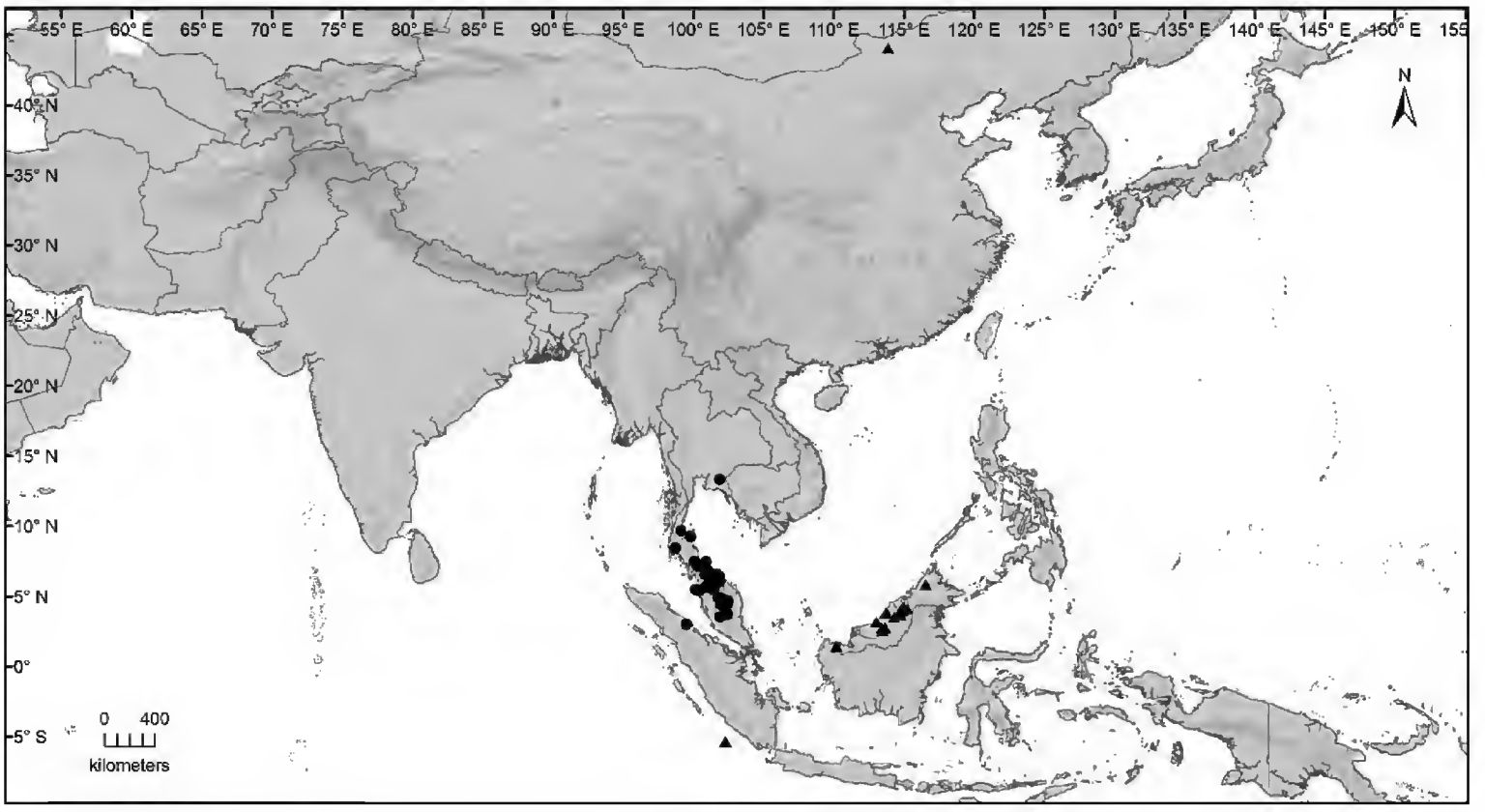

Fig. 9. Distribution of *Epithema membranaceum* (King) Kiew (●) and *Epithema sarawakense* Hilliard & B.L.Burtt (▲).

1.25–3.5 × 1.3–2.3 mm; lobes 0.6–3.1 × 0.75–2.5 mm; indumentum outside as on pedicel, sub-glabrous inside, a few hairs in lobes. ***Corolla*** colour variable, white, pale pink, pale violet, pale blue or purple or whitish-purple with purple markings, 3.5–7 mm long; tube 2.5–5 × 2 mm, lobes 1–1.9 mm long; pubescent outside, hairs hooked and straight to 0.1 mm long, with a band of villous hair inside. ***Stamen*** filaments 0.75–0.8 mm long; anther characters unknown; staminodes 0.6 mm long. ***Nectary*** of one lobe almost or entirely encircling ovary, 0.75–1 × 2.2 mm. ***Ovary*** spherical or sub-spherical, 0.75–1 × 0.6–1 mm, pubescent, hairs medium to high density, fine, hooked, rarely with one or two straight hairs, hyaline, on upper portion of ovary; style 2–3.8 mm long, occasionally glabrous, pubescent on lower to mid-style, hairs hooked, to 0.13 mm long; stigma c. 0.4 mm wide. ***Fruit*** obovate to cylindrical, 2–3 × 2–3 mm; operculum 1 mm long, pubescence as for ovary. ***Seeds*** narrowly ovoid to ovoid, 0.3–0.5 × 0.1–0.2 mm, dark brown, pattern straight to spiralled, regular.

Distribution. Thailand, Peninsular Malaysia, Indonesia (Sumatra).

Habitat and ecology. Primarily on limestone, occasionally granite, in shaded areas of evergreen forests near waterfalls or streams. Found in lowland dipterocarp forests in Malaysia at 30–415 m altitude. Flowering and fruiting February, April–December.

Provisional IUCN conservation assessment. Least Concern (LC). This species is common and widespread although, as it mostly occurs on limestone and limestone habitats which are often threatened, its status should be monitored.

Additional specimens examined. THAILAND: **Chachoengsao:** Khao Tak Groep, 6 Nov 1993, *Larsen, K. et al. 44271* (AAU). **Nakhon Si Thammarat:** Kha Nom, Khuan Thong, Khao Krod Cave, 20 Dec 2006, *Pooma, R. et al. 6486* (E); Nop Phitum, Khao Luang National Park, Khao Luang, 25 Oct 1991, *Larsen, K. et al. 42584* (AAU); ibidem, 25 Oct 1991, *Larsen, K. et al. 42579* (AAU). **Narathiwat:** 21 Dec 1968, *Phusomsaeng, S. et al. 19* (BKF, E); Bacho National Park, 11 Oct 1991, *Larsen, K. et al. 42312* (AAU, P); Sungai Padi, Chatvarin Falls, 18 Oct 1970–19 Oct 1970, *Charoenphol, C. et al. 3976* (AAU, E, K, L); Pattani, Khao Chai Son, 23 Dec 2006, *Pooma, R. et al. 6578* (E); Pattani, Sai Khao Waterfall, 9 Oct 1991, *Larsen, K. et al. 42245* (AAU); ibidem, 20 Dec 1972, *Santisuk, T. & B.N. 451* (BKF). **Phatthalung:** Khao Chai Son, Road to Than Nam Yen, 23 Dec 2006, *Pooma, R. et al. 6579* (BKF); Kao Ok Thalu, 21 Apr 1928, *Kerr, A.F.G. 15775* (K). **Songkhla:** Khao Chang Lon, 24 Jul 1928, *Kerr, A.F.G. 15893* (K); Saba Yoi, Tham Ru Nok Sak (Cave), 21 Oct 1991, *Larsen, K. et al. 42471* (AAU, BKF); Tam ta Lord, 25 Nov 1990, *Larsen, K. et al. 41713* (AAU). **Surat Thani:** Khan Thuli, 6 Sep 1931, *Put 4118* (K). **Yala:** Bannang Sata, 26 Nov 1961, *Suvanakoses, P. 1727* (BKF, K, L, P); Nam Tok Than To Falls, 10 Dec 1966, *Sangkhachand, B. 1405* (BKF); Tahndo, Tahndo Falls Forest Park, 12 Nov 1986, *Maxwell, J.F. 86-893* (L, PSU); Than To, Bang Lang National Park, 17 Jul 2004, *Pooma, R. et al. 4298* (BKF).
MALAYSIA: **Peninsular Malaysia**: **Kedah:** Baling, 24 Apr 1987, *Stone, B.C. et al. 870424-5/1* (KLU); **Kelantan:** Gua Musang, 11 Aug 1971, *Chin, S.C. 1404* (KLU); ibidem, 1 Nov 1967, *Shimizu, T. & Stone, B.C. 14427* (KYO); Kuala Betis, 15 Feb 2003, *Kiew, R. RK5254* (E, SING). **Pahang:** Bentung, Bukit Chintamani, 3 Oct 1931, *Henderson, M.R. 25010* (BO, SING); Gua Tipus, 10 Aug 1929, *Henderson, M.R. 22580* (SING); ibidem, 15 Oct 1927, *Henderson, M.R. 19406* (BO); Gunung Senyum, 30 Jul 1929, *Henderson, M.R. 22382* (BO, SING); ibidem, 28 Nov 1984, *Kiew, R. RK1590A* (UPM); Kota Gelanggi, 28 Nov 1984, *Kiew, R. RK1584* (UPM); Merapoh, Gua Layang, 13 Aug 1971, *Chin, S.C. 1514* (E, K); Taman Negara, Batu Luas, 21 Oct 1982, *Kiew, R. RK1231* (UPM); Taman Negara, Batu Luas, Gua Daun, 1 Oct 1984, *Kiew, R. RK1347* (UPM); Taman Negara, Gua Luas, *Wilkie, P. FRI52899* (E). **Penang:** 1822, *Wallich, N. 9080* (K). **Perak:** Grik, Temenggor Dam, 9 Sep 1993, *Turner, I.M. & Yong 158* (SING); Grik, Temenggor Dam, Sungei Singor, 8 Nov 1993, *Saw, L.G. FRI39945* (K).
INDONESIA: **Sumatera Utara:** Asahan, 12 May 1927–21 May 1927, *Bartlett, H.H. 7740* (US).

Notes. This species is usually quite delicate and distinctive in its vegetative form. Usually the lower and middle petioles are 0.7–1.5 times the length of the leaves which are all cordate-ovate with sub-cordate to sub-auriculate leaf bases. The petiole/leaf length ratio decreases up the plant as in all petiolate species of *Epithema*, but even the uppermost petioles often appear long in comparison to other species. The curved asymmetric upper leaves of some plants are also seen in *Epithema steensii* and occasionally in *E. tenerum*. While peduncles usually originate in the axils of terminal leaves, a small number of specimens also have peduncles arising from the base of the petioles of the terminal leaves.

Epithema membranaceum can be similar to *E. parvibracteatum* and more rarely to *E. saxatile*. The similarity to *Epithema parvibracteatum* is discussed under that species. Label data suggests that *Epithema membranaceum* co-occurs with *E. saxatile* on Gunung Senyum and at Batu Luas, both in Pahang, Peninsular Malaysia. *Epithema membranaceum* can be separated from *E. saxatile* by the size of the bract, pubescence on the style and shorter hairs on the ovary/operculum.

11. *Epithema parvibracteatum* Hilliard & B.L.Burtt, Edinburgh J. Bot. 54: 112 (1997). – TYPE: Malaysia, Selangor, Batu Caves, 60 m, 3 November 1953, *Sinclair, J. 7821* (holotype E). (Fig. 10)

Herb 6.5–19.6 cm high, caulescent, indumentum of strigose and setose to hispid hairs, to 0.8–1.1 mm long on stem, petioles, upper leaf surfaces and peduncles; stem 0.8–4.4 mm wide with two nodes, internodes 1.2–3.5 cm long. ***Leaves*** membranous or strongly membranous, petiolate; petiole of lowest leaf 0.8–5 cm long, upper petioles 0.4–2 cm long, densely hairy; blade of the lowest leaf 2.6–11.3 × 1.8–8 cm, upper leaf blades 2.3–8.5 × 1.3–6 cm, leaves frequently asymmetrical, one side up to 1.4 times wider than the other, apex acute to broadly acute, base shallowly auriculate to obtuse, inserted evenly on petiole, margin sub-entire to dentate, bidentate or serrate; upper surface often with two clearly different lengths of hair at medium to high density; lower surface drying white-green, longest hairs primarily on veins and at margins. ***Inflorescences*** 1–5 per plant; peduncles (0.2–)0.5–10.8 cm long, terminal and in leaf axils, hispid; ***bracts*** small, rarely sub-cucullate or trullate, 1–7 × 2–7 mm, margin often deeply lobed with 3 lobes, but also dentate; lower surface densely hairy with hairs to 0.6 mm long, upper surface with primarily straight hairs to 0.6 mm long, mostly denser and longer towards margins; pedicels 0.8–4.2 mm long, sparsely to densely hairy, hairs hooked and to 0.2 mm long, also with or without longer straight hairs to 0.6 mm long. ***Calyx*** 3.5–4.3 mm; tube 1.5–2.9 × 1.7–2.7 mm, lobes 0.8 –2.9 × 0.6–1.9 mm; densely hispid throughout or mainly on lobes outside, hairs to 0.7 mm long; pubescent inside, hairs straight, on lobes. ***Corolla*** white, 4.2–5.4 mm long; tube cylindrical, 2.9–3.8 × 1–1.5 mm; lobes 0.8–1.3 mm long, margin entire; with few hooked hairs inside or with ring of villous hair. ***Stamens*** 1.1–1.6 mm long; filaments 0.6–1 mm long; anthers 0.5–0.6 mm long; staminodes 0.75–1 mm long. ***Nectary*** 1–3 discrete lobes, if three the third lobe is small, margin almost entire or undulate, 0.6–1.3 × 0.3–1.9 mm. ***Ovary*** spherical or sub-cylindrical, 1–1.3 × 0.9–1 mm, sub-glabrous to densely pubescent or pilose, hairs straight and/or hooked, dense on upper ovary, to 0.2 mm long; style 1.9–3.2 mm long, glabrous or with few straight and/or hooked hairs; stigma c. 0.3 mm wide. ***Fruit*** obovate to cylindrical to sub-spherical, 1.5–2.8 × 1.9–2.5 mm; operculum 0.4–0.9 mm long, indumentum as on ovary, hairs may be densest at the very top of the ovary. ***Seed*** narrowly to broadly ovoid, 0.3–0.5 × 0.1–0.2 mm, light brown to medium brown, pattern almost straight to spiralled, reasonably regular.

Distribution. Peninsular Malaysia.

Habitat and ecology. On limestone or other rocks, in shade, often in crevices of limestone, at 60–150 m altitude. Flowering and fruiting February, May, July–November.

Provisional IUCN conservation assessment. Least Concern (LC). This species is fairly widespread in Peninsular Malaysia although, as it mostly occurs on limestone and limestone habitats which are often threatened, its status should be monitored.

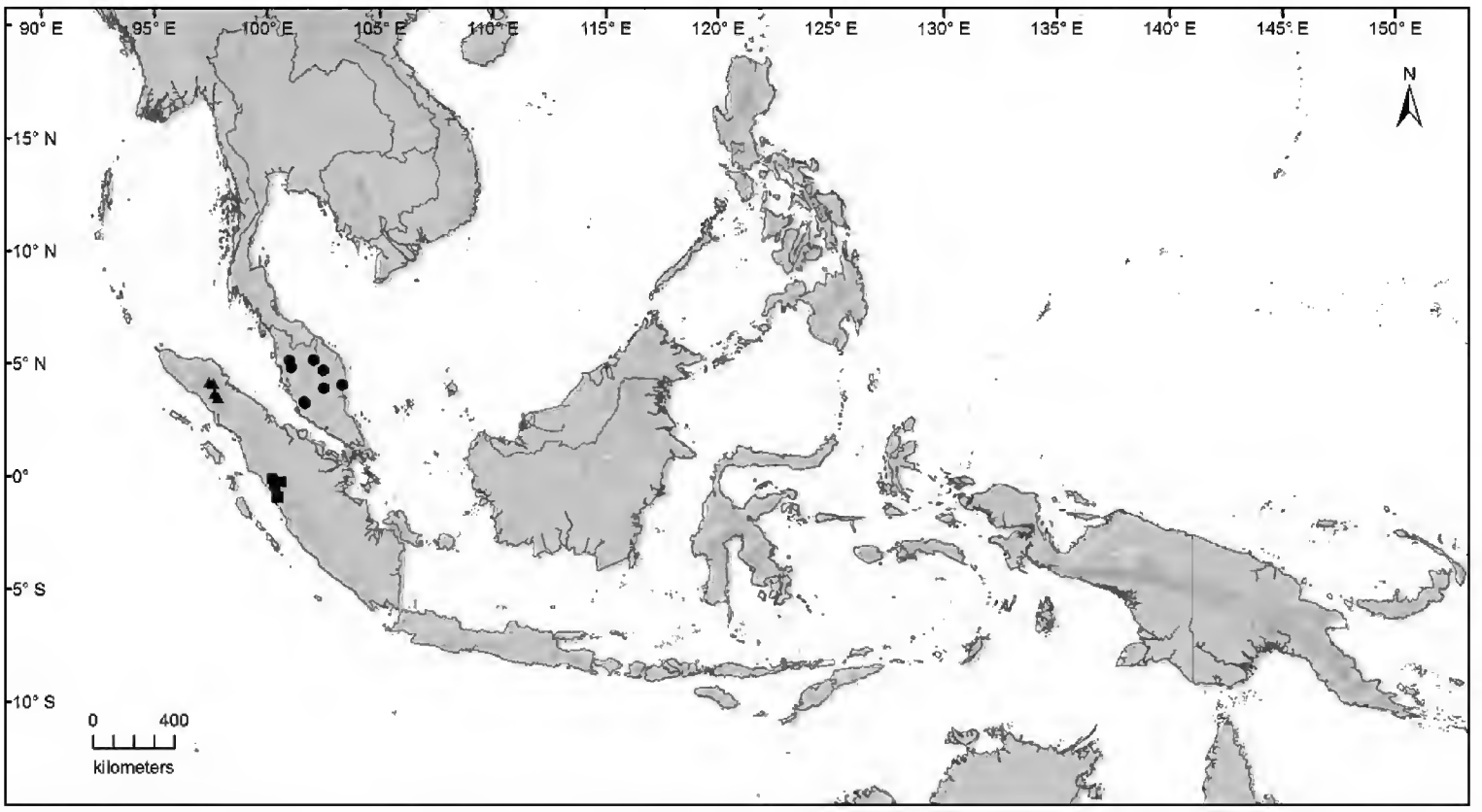

Fig. 10. Distribution of *Epithema parvibracteatum* Hilliard & B.L.Burtt (●), *Epithema steenisii* Hilliard & B.L.Burtt (▲) and *Epithema strigosum* (C.B.Clarke) Hilliard & B.L.Burtt (■).

Additional specimens examined. MALAYSIA: **Peninsular Malaysia**: **Kelantan:** Ulu Kelantan, Bertram, 30 Jul 1962, *Unknown 147* (K, L). **Pahang:** Kota Gelanggi, Aug 1891, *Ridley, H.N.* s.n. (SING); Kuantan, Kuantan-Kemaman Road, 19 Jul 1979, *Kochummen, K.M. FRI26221* (L); Taman Negara, Batu Subuh, 8 Oct 1984, *Kiew, R. RK1498* (UPM). **Perak:** Hulu Perak, Lenggong, Kpg. Gua Badak, 28 Oct 2008, *Imin, K. FRI63208* (SING); Kamuning, Feb 1904, *Ridley, H.N. 11883* (K). **Selangor:** Kanching, Bukit Anak Takun, 4 Oct 1969, *Stone, B.C. 8830* (KLU); ibidem, 29 May 1970, *Stone, B.C. & Mahmud 8400* (KLU). **Selangor:** Kanching, Bukit Takun, 27 Sep 1970, *Chin, S.C. 392* (KLU); ibidem, 24 Oct 1967, *Shimizu, T. & Stone, B.C. 13739* (KYO).

Notes. The distinguishing characters for this species are a small bract and the dense and long hair covering, particularly on the peduncles, pedicels and calyx. In addition, the corolla is quite small, only 4.2–5.4 mm long. There is considerable variation in the ovary/operculum hair. This variation was observed both within a single inflorescence and between specimens. Variation in the type of hair found on the inside of the corolla is unusual and, apart from *Epithema parvibracteum*, is only seen in *E. horsfieldii* and *E. rennellense*.

The larger plants are rather similar to *Epithema membranaceum* and some also to *E. saxatile*. The specimens of *Epithema parvibracteatum*, however, have an extremely reduced bract and a hispid indumentum on the inflorescence.

12. *Epithema philippinum* (Hilliard & B.L.Burtt) Bransgrove, **stat. nov.** – *Epithema strigosum* subsp. *philippinum* Hilliard & B.L.Burtt, Edinburgh J. Bot. 54: 113 (1997).

– TYPE: Philippines, Mindanao, Surigao, Mt Kabatuan, 83 m, 18 March 1949, *Mendoza, D.R. & Convocar, P.P. 297* [PNH10434] (holotype PNH; isotype A). (Fig. 6) ***Herb*** 6–13 cm high, usually acaulescent with leaves arising near ground level; stem 1–2.5 mm wide with 0–1 nodes, internode if present 1.4–2.3 cm long; stem densely pubescent, hairs to 0.5 mm long. ***Leaves*** strongly membranous, petiolate, with one or more inflorescences opposite each solitary leaf; petioles 2–20 cm long; blade 3–11 × 2.4–4.4 cm, cordate, symmetrical, apex and tip acute, base cordate to truncate, inserted evenly on petiole, margin dentate and/or bidentate or crenate; upper surface weakly to strongly strigose, sometimes with setose hairs, hairs straight, hooked or a combination of both, to 0.7 mm long; lower surface pubescent, hairs to 0.4 mm long. ***Inflorescences*** 1–2 per plant; peduncles 1.6–10.5 cm long, originating opposite solitary leaves, strigose and setose, hairs dense, to 0.6 mm long; ***bracts*** cucullate but not enclosing entire inflorescence, 3–8 × 3–8 mm, margin dentate; lower surface strigose, sometimes with two distinct lengths of hair or layers of hair visible, hairs to 0.4 mm long; upper surface strigose, on entire surface but denser towards margins, hairs to 0.3 mm long; pedicels 1.2–3.8 mm long, pubescent or hispid, hairs primarily straight, to 0.4 mm long. ***Calyx*** cylindrical, 3.5–5.5 mm long; tube 2.3–3 × 1.5–3 mm; lobes 1.2–2.5 × 0.8–1.3 mm; outside with a minute hooked pubescence and longer, primarily straight hairs covering the entire calyx or only on lobes, straight hairs 0.2–0.4 mm long, hooked hairs 0.13–0.3 mm long; hairs on lobes inside. ***Corolla*** bluish, 5–6 mm long; tube cylindrical, 3.7–4.2 × 1.2–3 mm; lobes 1.5–2 mm long; band of villous hair inside in upper tube. ***Stamens*** 1–1.5 mm long; filaments c. 0.7–1 mm long; anthers c. 0.5 mm long; staminodes 0.7–1 mm long. Nectary of two discrete lobes nearly encircling ovary, 0.8–1.5 × 0.7–1.5 mm. ***Ovary*** sub-cylindrical or sub-spherical, 0.7–1.3 × 0.7–1.2 mm, upper part of ovary densely pubescent to pilose, hairs straight, to 0.1 mm long; style 3.7–4.6 mm long, glabrous or with few straight hairs at base; stigma c. 0.4 mm wide. ***Fruit*** sub-cylindrical or sub-spherical, 1.9–2.8 × 2–2.5 mm; operculum 0.6–0.9 mm, indumentum as on ovary. ***Seed*** narrowly ovoid to ovoid, 0.4–0.5 × 0.1–0.2 mm, medium to dark brown, pattern straight to spiralled, regular, infrequently splitting and merging.

Distribution. Philippines (Mindanao).

Habitat and ecology. Lithophytic, probably on limestone in humid, shady areas. Recorded at 83 m altitude. Flowering and fruiting March.

Provisional IUCN conservation assessment. Data Deficient (DD). This species is only known from two quite old collections and the current status of the species is unknown. The area where these collections were made is still largely forested so the population may still be in good condition.

Additional specimen examined. PHILIPPINES: **Mindanao: Agusan:** Jabonga, Kitsarao, 14 Mar 1949, *Mendoza, D.R. & Convocar, P.P. 226* [PNH10394] (PNH).

Notes. Epithema philippinum is most similar to *E. strigosum*. See discussion under *Epithema strigosum* regarding the differences between *E. philippinum* and *E. strigosum*.

Plants of *Epithema philippinum* that only have one leaf opposite one or more peduncles could also be confused with *E. horsfieldii* but is most easily distinguished by the straight hairs on the ovary and operculum in *E. philippinum* (hooked in *E. horsfieldii*).

13. *Epithema pusillum* (C.B.Clarke) Bransgrove, **stat. nov.** – *Epithema carnosum* var. *pusillum* C.B.Clarke, Monogr. Phan. 5(1): 178 (1883). – *Epithema dentatum* var. *pusillum* (C.B.Clarke) Hilliard & B.L.Burtt, Edinburgh J. Bot. 54: 112 (1997). – TYPE: India, Bombay, *Stocks s.n.* (holotype K). (Fig. 3).

Herb 4.5–12 cm high, caulescent, indumentum of straight and hooked hairs; stem 1 mm wide with two nodes 1.2–4 cm apart and 1–8 cm to the first node, stem sub-glabrous to sparsely pubescent, 0.2 mm long. ***Leaves*** thinly membranous, petiolate; petiole of lowest leaf 1–2 cm long, petioles of upper leaves 0.1–1.8 cm long, pubescent, hairs to 0.2 mm long; blade of the lowest leaf 4.3–6 × 1.8–4.5 cm, upper leaves 2–6.5 × 1.2–4.8 cm, lowest leaf broadly ovate, upper leaves ovate, all symmetrical, apex acute to rounded, base sub-cordate to truncate, inserted evenly on petiole, margin serrate; upper surface weakly strigose, hairs sparse, hyaline and/or white, 0.4 mm long; lower surface sub-glabrous to sparsely pubescent with primarily hooked hairs to 0.5 mm long. ***Inflorescences*** 1–3 per plant; peduncles 1–2.5 cm long, usually originating from axils of terminal leaves, indumentum sparse, strigose, straight hairs to 0.3 mm long, or with a sparse to dense minute hooked pubescence; ***bracts*** small and sub-cucullate to cucullate but not enclosing entire inflorescence, 4–8 × 4–9 mm, margin sub-entire with occasional dentation; lower surface glabrous or sub-glabrous; upper surface glabrous; pedicels 1.9–2.5 mm long, glabrous or with a minute, sparse pubescence. ***Calyx*** 2.1–4.6 mm long; tube 0.8–2.5 × 1.7–2.5; lobes 1–2.1 × 0.7–2.1 mm; usually glabrous or with a minute hooked pubescence, sometimes with additional straight and/or hooked hairs to 0.33 mm long outside; glabrous inside. ***Corolla*** white, c. 6 mm long; tube c. 4.6 mm long; lobes c. 1.4 mm long; glabrous outside, with villous band of hair inside in upper half. ***Stamen*** and staminode characters unknown. ***Nectary*** of one lobe, almost encircling the ovary, c. 0.8 × 0.8–1.8 mm, margin entire or sub-entire. ***Ovary*** sub-cylindrical to sub-spherical, 0.5–1 × 0.5–1 mm, glabrous; style c. 4 mm long; stigma c. 0.5 mm wide. ***Fruit*** sub-cylindrical, 1.5–2.3 × 2.1–2.3 mm; operculum c. 0.6 mm, glabrous. ***Seed*** elliptic to fusiform, 0.4–0.5 × 0.1–0.2 mm, pattern partially spiralled to spiralled.

Distribution. India (Maharashtra).

Habitat and ecology. Lithophytic and epiphytic (on at least *Dysoxylum* sp.) in humid, probably shaded, places. Recorded from 739 m altitude. Flowering and fruiting September.

Provisional IUCN conservation assessment. Data Deficient (DD). This species is only known from three collections, none of which were collected recently. The area where these collections were made has been heavily deforested and a survey of the status of this species is, therefore, vital.

Additional specimens examined. INDIA: **Maharashtra:** Ratnagiri, Amboli Ghat, Temple Point, 3 Sep 1968, *Kulkarni, B.G. 108673* (E); Savantwadi, 30 Sep 1978, *Almeida, S.M.* s.n. (E).

Notes. Epithema pusillum is easily separated from the species under which it has been included as a variety, *E. dentatum* (now *E. ceylanicum*) and *E. carnosum*, by its glabrous ovary. *Epithema pusillum* is only known from central, western peninsular India. The specimen from Amboli Ghat is not as fine as the other two specimens seen here, but the ovary and the fruit, however, are consistently glabrous.

14. *Epithema rennellense* Hilliard & B.L.Burtt, Edinburgh J. Bot. 54: 112 (1997). – TYPE: Solomon Islands, Rennell Island, 18 August 1962, *Dissing, H. 2738* (holotype E; isotypes E, C).

Herb 12–27 cm high, often with an acaulescent appearance with first leaves arising near ground level, indumentum of short pubescent hairs and longer strigose or hispid hairs, the latter up to 0.8 mm long on petioles, upper leaf surfaces, peduncles, pedicels and outer calyces; stem 2–4.4 mm wide with one or two nodes, internodes 3.5–11.7 cm long. ***Leaves*** membranous to strongly membranous, petiolate, leaves solitary; petiole of lowest leaf 7–13 cm long, upper petioles 2.5–11.5 cm long; blade of lowest leaf 6–11.5 × 4.2–9.3 cm, upper leaf blades 4–14 × 3.4–10 cm, all blades cordate to oblong cordate or sub-orbicular, symmetrical or not, if asymmetrical, one side up to 1.4 times wider than the other, apex acute to rounded, base shallowly auriculate to rounded, inserted evenly on petiole or slightly offset, margin dentate, bidentate or serrate; lower surface light green or drying white-green, often finely pubescent or hispidulous. ***Inflorescences*** 1–2 per plant; peduncles 2–21 cm long, originating opposite single leaves or occasionally in leaf axil; ***bracts*** sub-cucullate to cucullate, occasionally small, enclosing the entire inflorescence or portion thereof, 3–13 × 4–10 mm, margin entire with occasional crenate or dentate lobes to dentate; upper surface sub-glabrous to sparsely pubescent, hairs to 0.2 mm long, usually on upper portion of bract; pedicels 1.3–5 mm long. ***Calyx*** light green, 4.2–7.5 mm long, tube (1.7–)3–4.2 × (1.5–)2–3 mm, lobes 1.5–5 × 1–1.5 mm; glabrous to sparsely strigose on lobes inside, hairs straight or straight and hooked, to 0.13 mm long. ***Corolla*** white, 10.4–15 mm long; tube 6–11 × 2–3.3 mm; lobes 3–4.6 mm long, margin uneven/undulate; glabrous or sub-glabrous or with a band of villous hair inside. ***Stamens*** 1.2–3.1 mm long; filaments 0.7–2.1 mm long; anthers 0.5–1 mm long; staminodes 0.8–1.5 mm long. ***Nectary*** variable, one lobe (not entire) encircling ovary or with two discrete lobes not encircling ovary, 0.6–1.6 × 0.7–3.5 mm, margin entire to undulate. ***Ovary*** 1–1.6 × 0.8–1.6 mm, sub-glabrous or pubescent at sparse to medium density on upper portion

of ovary, hairs hooked or both straight and hooked, 0.04–0.3 mm long; style to 8.8 mm long, glabrous or with few hairs at base, hairs straight and hooked; stigma c. 0.5 mm wide. ***Fruit*** obovate, cylindrical or sub-cylindrical, 2.5–4 × 1–3.3 mm; operculum 0.7–1.3 mm, indumentum as ovary, but often on top of operculum or densest on top of operculum. ***Seed*** narrowly ovoid to ovoid, 0.4–0.8 × 0.1–0.2 mm, light to dark brown, pattern straight to spiralled, reasonably regular, walls somewhat thickened and rigid.

Distribution. Solomon Islands (Rennell Island).

Habitat and ecology. Growing on well-drained hillsides over limestone (Rennell Island is a limestone, coral atoll) at 20–90 m altitude.

Provisional IUCN conservation assessment. Least Concern (LC). Although this species has not often been collected, and it is endemic to an island that is only 660 km2, the island is still largely forested and there is little evidence that the the population is under serious threat.

Additional specimens examined. SOLOMON ISLANDS: s.l. 1894, *Officers of H.M.S. "Penguin"* (K). **Rennell Island:** 21 Aug 1962, *Dissing, H. 2798* (C); 6 May 1968, *Sirute'e, B. et al. BSIP9621* (K, L, SING); Hutuna, 25 Mar 1965, *Wolff, T. 3004* (C); Matangi Area, 17 May 1969, *Gafui, I.H. & collectors BSIP14759* (K, L, SING); Nuipani, 14 Mar 1965, *Wolff, T. 3025* (C); Tuhungganggo, 24 May 1969, *Gafui, I.H. & collectors BSIP14763* (K, L, SING).

Notes. This species is similar to *Epithema longipetiolatum* and *E. strigosum* in the leaves arising at ground level. *Epithema rennellense* is also somewhat similar to *E. dolichopodum* but differs in peduncle length/plant height ratio, leaf shape and leaf margin, the length of the calyx and the corolla, the ovary/operculum hair and the size of the seed. The variation in the shape of the hair on both the ovary and the operculum, between hooked and both straight and hooked, can be seen on different fruit from the one plant. The variation in corolla hair is unusual and is seen in few other species, none of which are acaulescent species. *Epithema rennellense* has the largest seed of all species of *Epithema* and, along with *E. longitubum*, the largest flowers.

15. *Epithema sarawakense* Hilliard & B.L.Burtt, Edinburgh J. Bot. 54: 113 (1997). – TYPE: Malaysia, Sarawak, Fifth Division, Sungai Medalam, Gunung Buda, 20 June 1975, *Burtt, B.L. 8336* (holotype E; isotype SAR). (Fig. 9)

Herb 25–40 cm high, sprawling or caulescent, indumentum of pubescent or strigose and setose hairs, to 0.7 mm long on the lower leaf surface and calyx, to 1 mm long on the upper leaf surface; stem 1.2–5 mm wide with 2 to 4 nodes, internodes 1–8 cm apart long. ***Leaves*** membranous to strongly membranous, petiolate, primarily solitary, rarely with one or two sets of opposite leaves per plant; petioles 1–7 cm long; blade 2.2–17 × 1.4–13.2 cm, often cordate, but can be sub-orbicular, elliptic or sub-oblong,

symmetrical or not, if asymmetrical, one side up to 1.5 times wider than the other, apex acute to rounded, occasionally almost truncate, base usually (sub-)cordate but also to truncate, inserted evenly on petiole or not, margin sub-entire to dentate or bidentate; upper surface sparsely to densely strigose or villous, occasionally sub-glabrous; lower surface may dry grey-green, glabrous to villous. ***Inflorescences*** 3–11 per plant; peduncles 0.5–16 cm long, 1–5 arising in sequence opposite solitary leaves or rarely in the axils of upper opposite leaves; ***bracts*** cucullate, usually completely enclosing inflorescence, 10–32 × 6–12 mm, margin dentate or irregularly dentate; lower surface with hairs to 0.5 mm long; upper surface often glabrous; pedicels 1.3–4.6 mm long, often glabrous. ***Calyx*** 3.3–6.6 mm long; tube 1.5–3.5 × 1–3.1 mm, lobes 1.5–3.8 × 0.6–2.3 mm; frequently sub-glabrous to finely pubescent outside (short, hooked hairs), occasionally with sparse strigose hairs; inside glabrous or with few straight hairs, 0.1 mm long, in tips of lobes. ***Corolla*** white and pale blue to purple, pink, or mauve, may have darker markings on the lobes, 8.7–11 mm long; tube 6–7 × 1.5–2.5 mm, lobes 2.7–4.2 × 1.5–2.1 mm, margin slightly fimbriate. ***Stamens*** 3 mm long; filaments 1.5 mm long; anthers 1.5 mm long; staminodes 1.5–1.8 mm long. ***Nectary*** a single lobe, partially to completely encircling ovary, 1–1.3 × 1.2–2.5 mm, margin almost entire to undulate, occasionally almost dividing into smaller lobes. ***Ovary*** sub-cylindrical, 0.8–1 × 0.7–0.9 mm, usually glabrous, occasionally ovary pubescent with hooked hairs on upper ovary, hairs to 0.1 mm long; style c. 6 mm long, slightly wider at base, glabrous; stigma c. 0.4 mm wide. ***Fruit*** obovate-cylindrical, 2–3 × 1 mm; operculum glabrous, occasionally sub-glabrous, indumentum as on ovary. ***Seed*** narrowly ovoid to ovoid or somewhat sigmoid, 0.4–0.5 × 0.1–0.2 mm, light brown to dark brown, pattern straight or almost so, occasionally partially spiralled to spiralled.

Distribution. Malaysia (Sabah, Sarawak), Indonesia (Kalimantan, Sumatra: Pulau Enggano).

Habitat and ecology. Lithophytic on limestone (but substrate not always reported). Humid, shady areas, beside streams, limestone outcrops, cave entrances. Occasionally found on wood or on soil over rock. At 30–1250 m altitude. Flowering and fruiting year round.

Provisional IUCN conservation assessment. Least Concern (LC). This species is widespread with many of the collections having been made in the protected areas of Gunung Mulu National Park and Niah National Park.

Additional specimens examined. MALAYSIA: **Borneo: Sabah:** Tambunan, Crocker Range, Tambunan/Ranau Road, 5 Mar 1995, *Sugau, J. JBS96* (E). **Sarawak:** 1st Division, Jambusan, Gunung Batu , 6 Oct 1977, *Martin, P.J. S.39273* (E, K, L); Baram District, Jun 1894, *Haviland, G.D. & Hose, C. 3525 R* (K); Baram District, Batu Gading, 5 Jan 1965, *van Niel, J.P. 3554* (L); Baram District, Gunung Mulu National Park, Bukit Binarat, 28 Apr 1985, *Moktar, A. et al. S.49467* (E, K); Baram District, Gunung Mulu National Park, Deer Cave, 16 i 1978, *Hansen, C. 17* (C, E, SAR); ibidem, 16 Jan 1978, *Hansen, C. 17* (C, E); ibidem, 2 Oct 2007, *Julia, S. et*

al. S.99303 (E); ibidem, 5 May 1978, *Kiew, R. RK525* (E, UPM); ibidem, 16 Jan 1978, *Nielsen, I. 17* (E); ibidem, 23 Jul 1987, *Primack, R.B. S.42402* (K, L); Baram District, Gunung Mulu National Park, Gua Rusa, 30 Oct 1977, *Argent, G.C.G. & Kerby, R. 621* (E); Baram District, Gunung Mulu National Park, 22 Mar 1964, *Hotta, M. 15281* (E, KYO, L); ibidem, 14 Mar 1964, *Hotta, M. 14402* (E, KYO); ibidem, 19 Mar 1990, *Yii, P.C. & Abu Talib S.58618* (SAR); Miri, Mulu National Park, en route from HQ to Deer Cave, 20 Dec 1999, *Imaichi, R. et al. 30* (SAR); Miri, Mulu National Park, Royal Mulu Resort, 6 Oct 2001, *Julaihi S.86868* (SAR); Miri, Mulu National Park, Simons Cave, 27 Apr 1997, *Haegens, R.M.A.P. & Klazenga, N. 515* (SAR); Baram District, Gunung Mulu National Park, Melinau Gorge, 23 Jun 1962, *Burtt, B.L. & Woods, P.J.B. B. 2230* (E); ibidem, 20 Feb 1978, *Nielsen, I. 416* (E); Baram District, Gunung Mulu National Park, Pala River, 14 Nov 1977, *Argent, G.C.G. & Collins, M. 733* (E); Baram District, Ulu Melinau, Aug 1958, *Ashton, P.S. A. 339* (K); ibidem, Aug 1958, *Ashton, P.S. A. 340* (K); Baram District, Ulu Sg. Tutoh, Batu Kalulong, 13 Apr 1997, *Julaihi et al. S.76938* (SAR); Batu Niah, Nov 1932, *Synge, P.M. S.565* (K); ibidem, Nov 1932, *Synge, P.M. S.634* (K); Batu Niah, Gunung Subis, 28 Nov 1966, *Anderson, J.A.R. et al. S.26090* (A, E, K, L, SING); ibidem, Jan 1961, *Mohidin S.21608* (K); ibidem, 19 Aug 2002, *Sabli, J. et al. S.89048* (SAR); Batu Niah, Niah Cave Park, 4 Jun 1962, *Burtt, B.L. & Woods, P.J.B. B.2003* (E); ibidem, 3 Jun 1962, *Chew, W.-L. CWL.293* (K, L, SAR, SING); ibidem, 23 Dec 1999, *Imaichi, R. et al. 38* (SAR); ibidem, 20 Aug 2006, *Prieditis, N. s.n.* (E); ibidem, 20 Aug 2006, *Prieditis, N.* s.n. (E); ibidem, 18 Apr 1978, *Stone, B.C. 13730* (K, KLU, L); Belaga District, Bukit Merirai, Gua Pak Danum, 12 Jul 2005, *Leong, P. et al. PL320* (SING); Belaga District, Ulu Merirai, 9 Jul 2005, *Leong, P. et al. PL215* (SING); Belaga District, Ulu Merirai, Gua Tiang, 6 Jul 2005, *Julia, S. et al. S.93376* (SING); Bintulu, Ulu Sg. Kakus, Bukit Sarang, 14 Mar 1965, *Anderson, J.A.R. S.20957* (A, K); Bintulu, Ulu Sg. Kakus, Bukit Sarang, Batu Anyi, 5 Oct 2004, *Julia, S. et al. S.94757* (SAR, SING); Buseau, 1890, *Haviland, G.D. s.n.* (K); Kapit, Melinau, 16 Jul 1961, *Anderson, J.A.R. & Keng, H. K100* (SAR); Kapit, Ulu Melinau, Gunung Api, 1971, *Anderson, J.A.R. S.31770* (E, K, L, SING); ibidem, 10 Sep 1970, *Chai, P.* S.30372 (A, BO, K, L, SING); ibidem, 1970, *Lehmann, P.F. PFL. 596/S. 30372* (E); ibidem, 7 Sep 1970, *Lehmann, P.F. S.30091* (E, K, SAR); ibidem, 29 Mar 1990, *Yii, P.C. & Abu Talib S.58841* (SAR); ibidem, 29 Mar 1990, *Yii, P.C. & Abu Talib S.58841* (SAR); Lobang Rusa, 9 Jun 1975, *Burtt, B.L. B. 8227* (E, SAR); Lobang Rusa, Sungei Melinau Paku, 9 Feb 1966, *Chew, W.-L. CWL1017* (A, K, L, SING); Marudi District, The Pinnacles, Gunung Api, 17 Jun 1995, *Beaman, J.H. 11727* (K); Miri, Gunong Mulu National park, Hidden Valley, 5 Apr 1978, *Argent, G.C.G. et al. 905b* (E); Niah, 7 Oct 1954, *Ahmad 1* (SING); Niah National Park, 12 Dec 1981, *Rogstad, S.H. 728* (A). INDONESIA: **Sumatra: Bengkulu:** Pulau Enggano, Boea-boea, 11 Jun 1936, *Lütjeharms, W.J. 4598* (L); Pulau Enggano, Malakoni, 26 Jun 1936, *Lütjeharms, W.J. 5112* (BO, GH, K, L, P). **Kalimantan:** Peningin, *Jaheri 1522* (BO).

Notes. Epithema sarawakense is usually quite distinctive with its near complete lack of opposite leaves and one to five infloresences arising from the base of the solitary petiole. *Epithema sarawakense* is often densely hairy, giving the dried leaves a grey-green colour. There are two forms, however, one of which is glabrous or sub-glabrous. The glabrous form is found almost exclusively in Gunung Mulu National Park in the environs of Deer Cave and the base of Gunung Mulu. While there are a small number of collections of the pubescent form from near Deer Cave, it has primarily been collected from Gunung Api, Gunung Buda, Gunung Benarat, along Sungai Melinau and in the Melinau Gorge.

There are a small number of specimens that show some similarity to *Epithema saxatile*. These specimens have some opposite leaves but, in most cases, there are always solitary leaves with peduncles arising opposite the solitary leaf on the plant. These opposite leaves are unequal in size while *Epithema saxatile* has even-sized opposite leaves. In addition, the range of the corolla length of *Epithema sarawakense* is 8–11 mm while that of *E. saxatile* is 6.5–9.5 mm and the upper ovary/operculum of *E. sarawakense* is glabrous or sub-glabrous (hairs hooked) while the operculum of *E. saxatile* is always at least sparsely pubescent (hairs hooked). The specimens of *Epithema sarawakense* that are similar to *E. saxatile* are not segregated geographically from more typical *E. sarawakense*.

A small number of specimens from Pulau Enggano in Sumatra are included in *Epithema sarawakense*. While the distribution is difficult to explain, there are currently no characters to separate the specimens from the remainder of the species as found in Sarawak. They have shorter stems than is usual for *Epithema sarawakense*, thereby resembling *E. strigosum*, but they differ from *E. strigosum* in that the operculum is glabrous to sparsely pubescent with hooked hairs rather than dense and with straight hairs as in *E. strigosum*.

16. *Epithema saxatile* Blume, Bijdr. 738 (1826); Ridley, Fl. Malay Penins. 2: 539 (1923); B.L.Burtt, Thai For. Bull. (Bot.) 29: 94 (2001). – TYPE: Indonesia, Java, *Blume, C.L. 1029* (lectotype L [L0003232], designated here; probable isolectotype U [without number]). (Fig. 11, 12)

Epithema carnosum auct. non Benth.: Barnett, Fl. Siam. 3(3): 205 (1962), p.p.

Herb 6–40 cm high, caulescent; stem 2–5 mm wide with 2–5 nodes, internodes 1.2–10.5 cm long, usually glabrous or sub-glabrous. ***Leaves*** membranous to strongly membranous, petiolate or with sessile upper leaves, rarely with one or two solitary upper leaves; petiole of lowest leaf 2.5–12 cm long, upper petioles 0–2.5 cm long; blade of lowest leaf 7–20 × 6.5–12.5 cm, upper leaves 4.5–13.5 × 3–8.5 cm, lowest leaf sub-spherical to broadly ovate, upper leaves variable, often narrowly ovate to almost oblong, but also cordate, broadly ovate or elliptic, symmetrical or not, if asymmetrical, one side up to 1.4 times wider than the other, apex acute to broadly acute, rarely rounded, base cordate to truncate, inserted evenly on petiole to distinctly offset (up to 2 cm), margin sub-entire to dentate, bidentate or serrate (often all or degrees of these on one plant); upper surface green or dark-green, indumentum occasionally to 1.1 mm long; lower surface light green, whitish or occasionally purplish. ***Inflorescences*** 1–10 per plant; peduncles 2–17 cm long, indumentum occasionally hispid, to 0.7 mm long; ***bracts*** cucullate, usually enclosing the entire inflorescence, 13–35 × 8–12 mm, margin usually dentate, occasionally sub-entire with one or two teeth or lobes; lower surface usually sparsely to densely strigose, hairs straight or primarily straight, 0.3–0.5 mm long; upper surface glabrous or sub-glabrous, hairs towards margins of bract; pedicels 1.1–4.2 mm long. ***Calyx*** 3.3–5 mm long; tube 1.6–3.3 × 1.5–2.1 mm; lobes 1.5–2.7 ×

Fig. 11. *Epithema saxatile* Blume. Flowers and cucullate bract. (Photo: David Middleton)

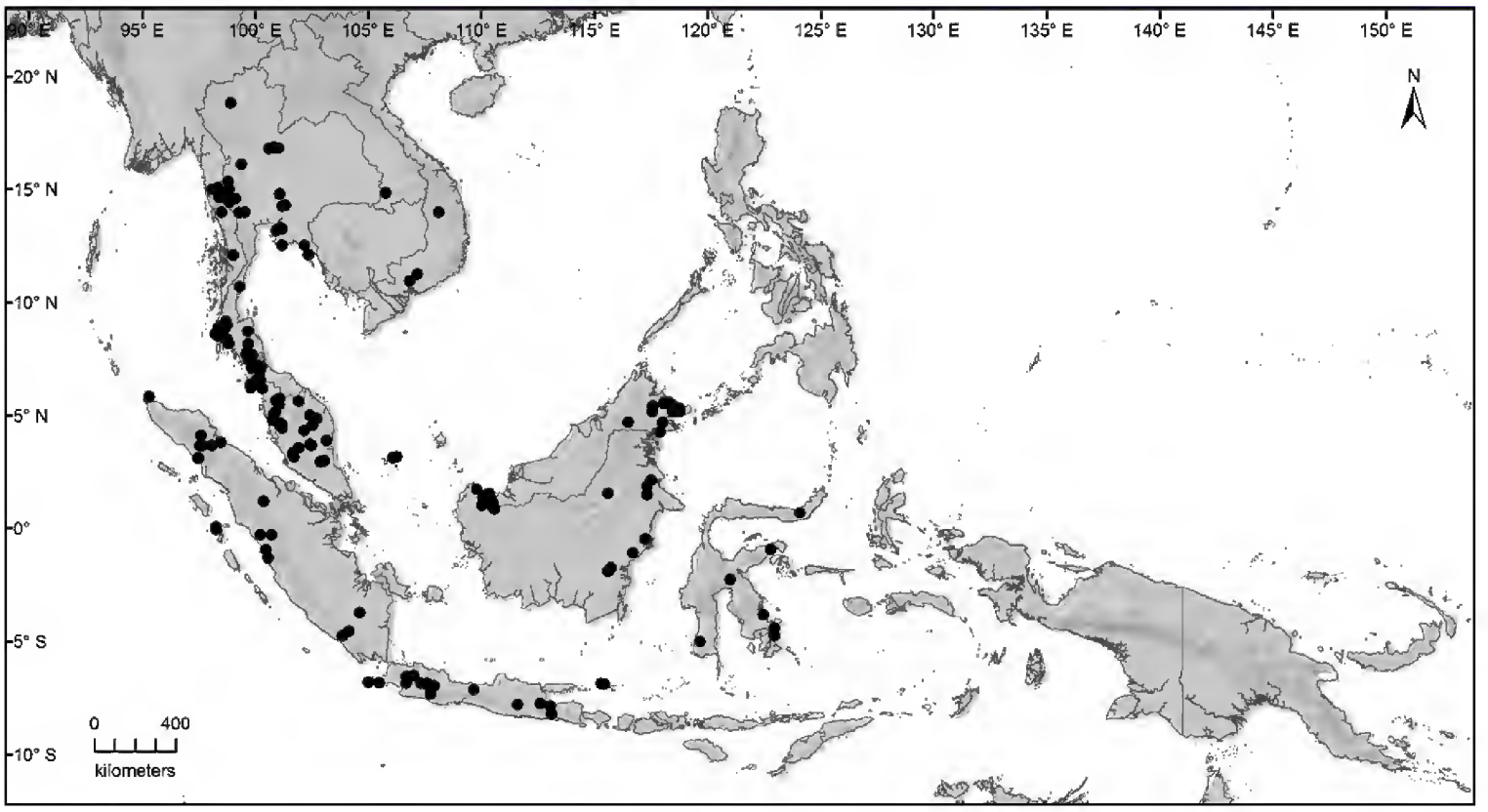

Fig. 12. Distribution of *Epithema saxatile* Blume (●).

0.6–0.9 mm, often glabrous at maturity, hairs to 0.5 mm long, glabrous inside. ***Corolla*** white, pink, blue, purple, or purple and white, frequently with highly variable purple markings on the upper lip, 6.5–9.5 mm long; tube 5–7 × 1.5–2.5 mm; lobes 1–3 × 1.7–2.3 mm; band of villous hair up to 1 mm wide inside. ***Stamen*** filaments 1.3–2.1 mm long; anthers c. 0.6 mm long; staminodes 1.3–2.1 mm long. ***Nectary*** apparently absent or with one or two lobes partially to entirely encircling ovary, margin undulate, 0.7–1.3 × 0.6–2 mm. ***Ovary*** sub-cylindrical or sub-obovate, 0.6–1.5 × 0.5–1 mm, very sparsely to densely pubescent, hairs hooked, on the upper or very upper portion of ovary, hairs 0.04–0.63 mm long; style 2.9–5 mm, glabrous or sparsely pubescent on the lower style; stigma 0.3 mm wide. ***Fruit*** cylindrical or obovate, 1.9–2.6 × 1.7–2.1 mm; operculum 0.4–0.7 mm long, pubescence as ovary. ***Seed*** narrowly ovoid to ovoid, 0.3–0.5 × 0.1–0.2 mm, pattern stright to spiralled, reasonably regular.

Distribution. Myanmar, Thailand, Malaysia (Peninsular Malaysia, Sarawak, Sabah), Indonesia (Sumatra, Java, Kalimantan, Sulawesi).

Habitat and ecology. Shaded, humid areas, usually on or amongst limestone rocks or in limestone soil, near, by or in streams or rivers. Also found near or on the walls of cave mouth entrances. At 0–910 m altitude. Flowering and fruiting hugely variable.

Provisional IUCN conservation assessment. Least Concern (LC). This species is common and widespread.

Additional specimens examined. MYANMAR: Tenasserim, 1877, *Gallatly, G. 1035* (SING); Tenasserim, Tavoy, Paungdaw, Aug 1961, *Keenan, J. et al. 798* (E).
THAILAND: **Chanthaburi:** Nam Tok Phliu National Park, Nam Tok Phliu Waterfall, 30 Aug 1969, *Maxwell, J.F.* s.n. (AAU); Priu Waterfall, 12 Oct 1965, *Chermsirivathana, C. 413* (BKF). **Chiang Mai:** Doi Sutep, 4 Aug 1912, *Kerr, A.F.G. 2655* (K); Me Ta Chang, 17 Oct 1922, *Kerr, A.F.G. 6381* (ABD, E, K). **Chon Buri:** Bahn Beung District, Ang Chang Nam, 1 Sep 1975, *Maxwell, J.F. 75-958* (AAU, BKF, L); Pong NamRawn, 3 Sep 1956, *Smitinand, T. 3489* (BKF, E); Sriricha, Chundaten Falls, 17 Aug 1974, *Maxwell, J.F. 74-814* (AAU, BK, L). **Chumphon:** Bang Son, 11 Sep 1927, *Put 1051* (ABD, K). **Kanchanaburi:** Between Huay Ban Kao and Kritee, 4 Jul 1973, *Geesink, R. & Phengklai, C. 6082* (BKF, E, L); ibidem, 12 Jul 1973, *Geesink, R. & Phengklai, C. 6231* (AAU, BKF, C, E, K, L, P). **Kanchanaburi:** Hindato, 24 Jul 1946, *Kostermans, A.J.G.H. 1346* (BO, A, L, P); Dongyai, 14 Aug 1971, *Phengklai, C. 2933* (BKF); Khaibuing, *CP, BS & BN 2997* (BKF, E, L); Kin Sayok, 13 Jul 1946, *Kostermans, A.J.G.H. 1103* (A, BO, L, P, SING, US); Lai Wo, Toong Yai Naresuan Wildlife Reserve, Ban Saneh Pawng, 12 Aug 1993, *Maxwell, J.F. 93-886* (CMU); Rintin, 31 Jul 1946, *Kostermans, A.J.G.H. 1401* (A, BO, L, P, SING, US); Si Sawat, Hua Lum Kao Ngoo, 5 Jul 1973, *Sutheeson, S. 2489* (BKF); Tawng Pa Poom, Huay Ban Khao, 12 Jul 1973, *Maxwell, J.F. 73-285* (AAU). **Khamphaeng Phet:** Khlong Lan National Park, 21 Aug 1995, *Parnell, J. et al. 95-335* (K). **Krabi:** 29 Mar 1930, *Kerr, A.F.G. 19385* (K); Ao Luk, 21 Jun 2006, *Williams, K. et al. 2033* (A); Nai Chong, 21 Oct 1979, *Sutheeson, S. 5004* (BKF). **Mae Hong Son:** Muang, Nahng Rawng Falls, 16 Sep 1972, *Maxwell, J.F. 72-362* (L). **Nakhon Nayok:** Nang Rong Falls, 13 Aug 1968, *Larsen, K. et al. 3363* (AAU, BKF, C, E, K, L, P, SING). **Nakhon Si Thammarat:** Thung Song District, Khao Tham Long, 31 Aug 1982, *Shimizu, T. et al. T.28985* (BKF); Nop

Phitum, Khao Luang National Park, Krung Ching Falls, 24 Sep 2010, *Middleton, D.J. et al. 5524* (E); ibidem, 12 Feb 2005, *Williams, K. et al. 1400* (E). **Phangnga:** Khao Lak, 21 Sep 1963, *Smitinand, T. & Sleumer, H.O. 1207* (BKF, L). **Phangnga:** Muang, Suan Somdet, 8 Dec 1999, *Wongprasert, T. 9912-30* (BKF); Muang, Tham Pha Phueng, 15 Sep 2010, *Middleton, D.J. et al. 5425* (E); Panga, Sep 1894, *Curtis, C.* s.n. (SING); ibidem, Aug 1893, *Curtis, C.* s.n. (SING); Pulau Tebun, 29 Dec 1918, *Nur, M. 3585* (K, SING); Takuapah, 14 Jul 1972, *Larsen, K. et al. 30967* (AAU, E); Tham Tong Lang, *Shimizu, T. et al. T.29151* (BKF). **Phatthalung:** Khao Pu-Khao Ya National Park , 24 Sep 1986, *Maxwell, J.F. 86-723* (A, BKF, L, PSU). **Phitsanulok:** N. Phitsanulok, Thung Salaeng Luang National Park, 22 Jul 1966, *Larsen, K. et al. 722* (AAU, BKF, L); ibidem, 25 Jul 1973, *Murata, G. et al. T.17092* (AAU, BKF, KYO, L); ibidem, *Phusomsaeng, S. et al. 83* (BKF); ibidem, 30 Sep 1967, *Tagawa, M. et al. T.11259* (KYO); Thung Salaeng Luang National Park, Kaeng Sopa Waterfall, 22 Oct 1984, *Murata, G. et al. 38544* (BKF); ibidem, 22 Oct 1984, *Murata, G. et al. T.38467* (BKF); Thung Salaeng Luang National Park, Kang So Pa Waterfall, 17 Sep 1990, *Chantharanothai, P. et al. 90/303* (K); Thung Salaeng Luang National Park, Poi Waterfall, 22 Oct 1984, *Murata, G. et al. T.38587* (BKF). **Saraburi:** Khao Muak Lek, 2 Oct 1963, *Bin Rajab, M.K. 714* (KLU). **Songkhla:** Boripath Waterfall, 1990, *Larsen, K. et al. 41243* (AAU); ibidem, 16 Aug 1984, *Maxwell, J.F. 84-55* (A, PSU); Boriphat Falls National Park, 9 Nov 1990, *Larsen, K. et al. 41243* (P). **Surat Thani:** Ban Kawp Kiep, 5 Aug 1927, *Kerr, A.F.G. 13183* (ABD, E, K). **Surat Thani:** Khlong Phanom National Park, *Middleton, D.J. et al. 4345* (BKF, E); Phanom, Khao Sok National Park, 6 Sep 2008, *Middleton, D.J. et al. 4330* (E); Phanom, Khao Sok National Park, Chong Lom, 12 Dec 1979, *Shimizu, T. et al. T.27103* (KYO); ibidem, 12 Dec 1979, *Shimizu, T. et al. T.27111* (BKF, KYO); ibidem, 12 Dec 1979, *Shimizu, T. et al. T.27100* (KYO); Phanom, Khao Sok National Park, Sii Ru Cave, 27 Feb 2006, *Middleton, D.J. et al. 4055* (BKF, E); Sawng Pi Nawng, 20 Mar 1927, *Kerr, A.F.G. 12385* (K). **Satun:** Khuan Don, Thale Ban National Park, Along cliff face from Ton Din Cave, 9 Sep 2010, *Middleton, D.J. et al. 5350* (E); Thale Ban National Park, 27 Aug 1995, *Larsen, K. et al. 46055* (AAU); Thung Wa, Than Plew Waterfall, 10 Sep 2010, *Middleton, D.J. et al. 5368* (E). **Trang:** Ampoe Kao Kao, Kao Chom Lem, 2 Aug 1929, *Rabil 318* (K). **Trang:** Ban Nam Phrai, 17 Dec 1979, *Shimizu, T. et al. T.27551* (BKF, KYO, L); ibidem, 17 Dec 1979, *Shimizu, T. et al. T.27571* (KYO); Chawng, 15 Mar 1959, *Smitinand, T. & Abbe, E.C. 6149* (BKF, K); Huay Yot, Wat Tham Iso, *Middleton, D.J. et al. 4428* (E, SING); Lamphura, 15 Nov 1990, *Larsen, K. et al. 41413* (AAU, BKF); ibidem, 16 Nov 1990, *Larsen, K. et al. 41450* (AAU); Trang, Nam Tai, 11 Oct 1970, *Charoenphol, C. et al. 3662* (AAU, E); ibidem, 11 Oct 1970, *Charoenphol, C. et al. 3661* (AAU, BKF); Trat, Koh Chang, 7 Sep 1992, *Niyomdham, C. 3276* (BKF). **Yala:** Betong, 27 Aug 1923, *Kerr, A.F.G. 7687* (K).

LAOS: **Champassak:** *Thorel, C.* s.n. (P); ibidem, *Thorel, C.* s.n. (P).

VIETNAM: Luang, Aug 1868, *Pierre, L. 4542* (P). **Dong Nai:** Bien Hoa, Cochinchine, *Pierre, J.B.L. 4541* (P); **Gia Lai:** Dak Doa, *Poilane, E. 18108* (P).

MALAYSIA: **Sabah:** 24 Feb 1985, *Lamb, A.L. 8/85* (E); Interior Zone, Batu Punggol, Apr 1987, *Vermeulen, J.J. 1188* (L); Kinabatangan District, Kori Timber Camp, 7 Nov 1948, *Cuadra, A. A.2168* (A, K, KEP, SAN, SING); Kinabatangan District, Northern Tabin Wildlife Reserve (Near Tabin River), 16 Oct 2000, *Poulsen, A.D. et al. 1659* (E); Lahad Datu, Bukit Baturong, 7 Jul 2000, *Kiew, R. RK5040* (SING); Lahad Datu, Tabin Wildlife Reserve, 24 Oct 2000, *Kiew, R. RK5120* (SING); ibidem, 25 Oct 2000, *Pius, G. et al. SAN143649* (E, K); Madai Baturong Forest Reserve, Baturong Hill, 12 Jun 1996, *Lim, S.P. et al. LSP738* (SING); Sandakan, Gomantong, 13 Feb 1960, *Meijer, W. SAN20756* (A, K, L); Sandakan, Gomantong, Gomantong Caves, 31 Oct 1968, *Kokawa, S. & Hotta, M. 551* (KYO); ibidem, 31 Oct 1968, *Kokawa, S. & Hotta,*

M. 557 (KYO); ibidem, 31 Oct 1968, *Kokawa, S. & Hotta, M. 565* (KYO); ibidem, 25 Sep 1968–26 Sep 1968, *Ogata, K. 10975* (KYO, L); Sandakan, Gomantong, Gomantong Hill, 20 Sep 1970, *Banggilon, K. SAN66579* (K, L); ibidem, 28 Apr 1996, *Lim, S.P. et al. 580* (SING); ibidem, 26 Apr 84, *Sands, M.J.S. & Young, R.G.N. 3936* (E, K); Sandakan, Hutan Simpan Gomanton, Between Gomantong Cave and Bukit Dulong Lambu, 10 Sep 1976, *Tamura, M. & Hotta, M. 602* (KYO); Sandakan, Tabin River, 16 Oct 2000, *Vermeulen, J.J. 2037* (SING); Sukau, Panggi, 18 Sep 1996, *Kiew, R. & Lim, S.P. RK4211* (K, SING); Tawao, Oct 1922–Mar 1923, *Elmer, A.D.E. 20569* (G, GH, K, SING). **Sarawak:** 1st Division, 28 May 1975, *Burtt, B.L. B.8207* (E); 1st Division, Bau, 24 Apr 1955, *Brooke, W.M.A. 9872* (L); 1st Division, Bau District, *Burtt, B.L. & Woods, P.J.B. B.1898* (E); 1st Division, Bau District, Bukit Jebong, 7 Aug 1970, *Lehmann, P.F. PFL364* (E); 1st Division, Bau District, Bukit Kapor, 22 May 1962, *Burtt, B.L. & Woods, P.J.B. B.1887* (E); 1st Division, Bau District, Fairy Cave, 9 Feb 1999, *Jemree, S. et al. S.82056* (SAR); 1st Division, Bau District, Seburan Mine, 24 May 1962, *Burtt, B.L. & Woods, P.J.B. B.1925* (E); 1st Division, Bau Limestone Hills, Bukit Boring, 14 Nov 1985, *Yii et al. S.50353* (K, L); 1st Division, Bau, Gunung Stulang, 16 Oct 2001, *Meekiong, K. SBC778* (SING); 1st Division, Bulit Majing, Tebakang, 16 Dec 1988, *Kessler 226* (L); 1st Division, Gunung Berloban, 19 Apr 1984, *Yii & Othman S.46225* (K, L); 1st Division, Jambusan, Poak Road, 16 Dec 1989, *Frodin, D.G. & Bin Ismawi, O. 2077* (K); 1st Division, Padawan, Bukit Megetang, 4 Mar 1969, *Wright, E. & Chai, P. S.27457* (E, K); 1st Division, Padawan, Gunung Regu, 6 May 1975, *Burtt, B.L. B.8089* (E); 1st Division, Taiton, *Yii et al. S.51207* (L, SAR); Bidi, Jul 1893, *Ridley, H.N.* s.n. (SING); Bidi Cave, Oct 1929, *Clemens, J. & Clemens, M.S. 7434* (NY); ibidem, 22 Oct 1929, *Clemens, J. & Clemens, M.S. 7627* (K); Kuching, *Idzumi, H. & Togashi, M.* s.n. (TI); ibidem, 29 Oct 1975–31 Oct 1975, *Idzumi, H. & Togashi, M.* s.n. (TI); Kuching to Padawan, 30 Sep 1981, *Croat, T.B. 53161* (SAR); Kuching, Daerah Kecil Siburan, Kampong Mambong, 12 Dec 1999, *Imaichi, R. et al. 2* (SAR); Kuching, Penrissen, Gunung Braang, 8 Dec 2000, *Jemree, S. et al. S.84036* (SAR); Kuching, Penrissen, Mambong, Gunung Bar, 19 Feb 1993, *Lai & Rantai et al. S.66009* (K, SAR); Kuching, Tiang Bekap, Mt. Mentawa, 11 Mar 1967, *Chew, W.-L. CWL.1288* (A, AAU, K, L, SING); Kuching, Tiang Bekap, Padawan Road, 3 Apr 1960, *Anderson, J.A.R. 12349* (K, L, SING); Samarahan , Serian District, Lobang Mawang, Bukit Selabor, 26 Sep 1968, *Ilias bin Paie S.28047* (K, L, SING); ibidem, 26 Sep 1968, *Ilias bin Paie S.28051* (K); Tambusan, Sep 1904, *Ridley, H.N.* s.n. (SING); Mongkos, Gunong Selebur, 20 Apr 1999, *Jamree et al. S.82239* (SAR); Serian District, Gunung Niyat, Ulu Sg. Majat, 27 Feb 2002, *Jemree, S. & Enjah, A. S.85584* (SAR). **Peninsular Malaysia: Kedah:** Baling, 5 Aug 1941, *Naven, J.C. 38038* (SING); Kota Setar, G. Keriang, 24 Jul 2009, *Rosdi, M. FRI66329* (SING); Pulau Langkawi, Gn. Raya Forest Reserve, 5 Oct 2010, *Chan, Y.M. FRI70632* (SING); Pulau Langkawi, Selat Panchor, 23 Nov 1934, *Henderson, M.R. 29079* (K, SING); Langkawi, 20 Nov 1941, *Corner, E.J.H.* s.n. (SING); ibidem, 20 Nov 1941, *Corner, E.J.H.* s.n. (SING); ibidem, Nov 1889, *Curtis, C. 2107* p.p (SING); ibidem, *Curtis, C. 2107a* (SING); Langkawi, Gunung Raya, 22 Aug 1988, *Anthonysamy, S. SA959* (SING); Pulau Langkawi, Pulau Dayang Buting, 23 Aug 1925, *Holttum, R.E. 15125* (BO); Langkawi, Pulau Langgun, 4 Nov 1971, *Chin, S.C. 1759* (KLU). **Kelantan:** Bukit Mangga, 20 Feb 2003, *Kiew, R. RK5276* (SING); Gua Maka, 19 May 1990, *Kiew, R. & Anthonysamy, S. RK3020* (SING); Kuala Aring, 1 Sep 1992–11 Sep 1992, *Hamid H18* (SING). **Pahang:** Bukit Cheras, 10 Oct 1901, *Henderson, M.R. 25205* (NY, SING); ibidem, 26 Nov 1984, *Kiew, R. RK1566* (UPM); Gunung Jebak Puyuh, *Kiew, R. RK2145* (UPM); Gunung Senyum, 22 Aug 1986, *Anthonysamy, S. SA515* (UPM); Kampong Sri Jaya, Bukit Batu, 28 Oct 1986, *Kiew, R. RK2369* (SING); Kuala Lipis, 25 Aug 2008, *Mohd Hairul, M.A. FRI60060* (SING); Kuantan, Bt Cheras, 25 Aug 1986, *Anthonysamy, S. SA558* (UPM); Kuantan, Bukit Panching, 26 Nov 1984, *Kiew, R.*

RK1570 (UPM); Maran, Jengka Forest Reserve, Hutan Lipur Jebak Puyuh area, 14 Oct 2008, *Mohd Hairul, M.A. FRI60066* (SING); Taman Negara, Batu Kepayang, 3 Oct 1984, *Kiew, R. RK1423* (UPM); Taman Negara, Batu Luas, 1 Oct 1984, *Kiew, R. RK1349* (UPM); Temerluh, Gn. Jebak Puyuh, Gn. Senyum, 9 Feb 2011, *Kamarul Hisham, M. FRI67230* (SING). **Perak:** Jan 1885, *King's Collector 7046* (SING); ibidem, Nov 1880, *Kunstler, H. 983* (SING); ibidem, 1890, *Ridley, H.N.* s.n. (SING); Batu Kurau, Dec 1884, *Scortechini 1580* (SING); Chemar, Perak Tong Temple, 23 Oct 1958, *Sinclair, J. 9846* (E, L, SING, US); Grik, Hutan Simpan Kemerong limestone area, 18 Nov 2011, *Mohd Hairul, M.A. FRI54071* (SING); Ipoh, 1 Dec 1966, *Ng, F.S.P. FRI1795* (L, SING); Ipoh, Gunung Rapat, 2 Mar 1959, *Allen, B.M. 4272* (SING); ibidem, 14 Jan 1983, *Davis 69304* (E); Kampong Jahang, Gunung Kanda, 5 May 1962, *Burtt, B.L. & Woods, P.J.B. B.1820* (E); Larut, Apr 1884, *King's Collector 5872* (SING); Larut & Matang, Lata Puteh, 22 Nov 2008, *Yao, T.L. FRI65393* (SING); Tambun, Rotan Segar, 29 Nov 1960, *Allen, B.M. 4654* (SING). **Perlis:** Besih Hangat, 17 Nov 1929, *Henderson, M.R. 22875* (SING); Bukit Bintang Forest Reserve, Bukit Bintang, 9 Aug 1986, *Weber, A. 860809-1/1* (E); Mata Ayer F.R., Bukit Rongkit, *Kiew, R. RK3712* (KEP); Wang Kelian, 28 Jun 1993, *Kiew, R. RK3653* (SING). **Selangor:** Kuala Lumpur, Jul 1890, *Curtis, C.* s.n. (SING); Batu Caves, 24 Aug 1908, *Ridley, H.N. 13380* (K, SING); ibidem, 4 Sep 1966, *Burkill, H.M. HMB4223* (SING); ibidem, 10 Jul 1906, *Ernst, A. 1118* (L); ibidem, 23 Jan 1966, *Hardial, S. & Sidek 474* (C, K, L, SING); ibidem, 9 Jun 1999, *Kiew, R. RK4711* (SING); ibidem, 15 Sep 1968, *Kokawa, S. 6381* (KYO); ibidem, Dec 1898, *Ridley, H.N. 8217* (SING); ibidem, Dec 1891, *Ridley, H.N.* s.n. (SING); ibidem, 30 Oct 1967, *Shimizu, T. & Fukuoka, N. M.14143* (AAU, K, KYO, L, SING); Genting Highlands, Ulu Gombak, 26 Oct 1937, *Nur, M. 34253* (SING). **Terengganu:** Batu Biwa, 22 Oct 1986, *Kiew, R. RK2287* (SING).

INDONESIA: **Java:** s.l., 1857–1861, *de Vriese, W.H.* s.n. (L); *Unknown 2648* (L); Gunung Burung (Gunung Bunder), 19 Dec 1893, *Schiffner, V.F. 2567* (A, BO, K, L); Gombak, Sempor, 17 Apr 1936, *Brinkman, R. 672* (BO). **Jawa Timur:** s.l., *Coert, J.H. 1093* (L); Kangean Island, Ardjasa, 1920, *Backer, C.A.B. 26969* (BO); Kangean Island, Batoe Poetih, 28 Mar 1919, *Backer, C.A.B. 27805* (BO); Kangean Island, Tambajangan, 22 Mar 1919, *Backer, C.A.B. 27410* (BO); Soekapoera, 3 Jun 1927, *Backer, C.A.B.* s.n. (BO); Tretes, Gunung Ardjoeno, May 1919, *Bremekamp, C.E.B.* s.n. (BO); Zuidergebergte, 27 Mar 1927, *Backer, C.A.B. & Posthumus, O.* s.n. (BO); Madioen, Ngebel, 16 Mar 1898, *Koorders, S.H. 29801* (K, L); Pogal, *Mousset 450* (BO, L). **Jawa Tengah:** Lebak Barang, 12 Jan 1918, *Backer, C.A.B. 23287* (BO). **Jawa Barat:** Pasir Masigit, Feb 1933, *Jacobson, E. 213* (BO); Papandajan, Mar 1930, *van der Pijl, L.* 205 (BO); Bandung, *Zollinger, H. 2002* (G, GH, P, S); Bogor, 1909, *Backer, C.A.B.* s.n. (L); Bogor, Gunung Tjibodas , Feb 1912, *Backer, C.A.B. 2480* (L); Cibodas, 1910, *Backer, C.A.B. 32476* (BO); ibidem, 1917, *Backer, C.A.B. 22091* (BO); ibidem, 1917, *Backer, C.A.B. 22091* (BO); ibidem, 18 Mar 1928, *van Steenis, C.G.G.J. 616* (BO); Tjiampea, Gunung Tjibodas, 15 Feb 1924, *Bakhuizen van den Brink, R.C. 3568* (BO, L); ibidem, 30 Jan 1921, *Bakhuizen van den Brink, R.C. 5153* (BO, L); Klappa Noenggal, 1912, *Backer, C.A.B. 5848* (BO, L); Padelarang, Kampong Sempang, *Coert, J.H. 625* (L); Res. Preanger, Tjidadap, Tjibeber, 23 Feb 1917, *Bakhuizen 2608* (L); Tjampea, *Burck, W. & de Monchy, B.J.* s.n. (BO); ibidem, 9 Feb 1913, *Koorders, S.H. 40438* (BO); ibidem, *de Monchy, B.J.* s.n. (L); ibidem, 4 May 1895, *Hallier, H.G. 91* (L); ibidem, 25 Sep 1904, *Hochreutiner, B.P.G.* 1916 (G); Ujung Kulon National Park, Tjilintang, 25 Apr 1963, *Wirawan, N. 45* (A, BO, K, L, SING); Palimena, Mont. Prope, *Junghuhn, F.W. 3* (K, L). **Sumatra:** s.l., *Yates, H.S. 1939* (NY). **Aceh:** Gajolanden, 25 Feb 1937, *van Steenis, C.G.G.J. 9267* (BO, K, L); Gaju and Alas Lands, Pendeng to Bivouac Aer Putih Waterfall, 17 Feb 1937, *van Steenis, C.G.G.J. 8879* (BO, L); Gunung Leuser Nature Reserve, Ketambe Research Station, Gunung Giring, 17 Mar 2008, *Wilkie, P. et al. PW764* (E);

Gunung Leuser Nature Reserve, Ketambe, Mt Ketambe, 24 May 1972, *de Wilde, W.J.J.O. & de Wilde-Duyfjes, B.E.E. 12353* (BO, K, L); Ketambe, 17 Mar 2008, *Sumadijaya, A. AX360* (BO); Kloet Nature Reserve, South Kloet, Pucuk Lembang, 10 Jul 1985, *de Wilde, W.J.J.O. & de Wilde-Duyfjes, B.E.E. 19894* (BO, L); Pulau Weh, Sabang, 31 Dec 1933, *van Steenis, C.G.G.J. 5734* (BO). **Lampung:** Gunung Rati, 24 Nov 1921, *Unknown 208* (BO, L); Muaradua, 13 Apr 1929, *de Voogd, C.N.A. 357* (BO, L). **Riau:** Anambas Islands, Siantan Island, Terempak, 6 Apr 1928, *Henderson, M.R. 20277* (K, SING). **Sumatera Barat:** Jorong Gasang, Lake Maninjau, 18 Jun 2011, *Puglisi, C. & Hughes, M. CP61* (BO); Padang, Indarung, Kampong Putih, 16 Feb 1981, *Hotta, M. & Okada, H. 247* (KYO); Pajakumbuh, Halaban, 2 Feb 1958, *Maradji 482* (L, SING). **Sumatera Selatan:** Aer Telanai, 11 Nov 1929, *Van Steenis, C.G.G.J. 3925* (BO). **Sumatera Utara:** Pulau Tello, Nov 1924, *Boden-Kloss, C.* s.n. (SING); Batu Islands, Pualu Telo, 23 Jan 1897, *Unknown* 654 (BO); Upper Langkat, 6 Nov 1938, *Lörzing, J.A. 17359* (BO); Wampu, 1918–1919, *Lesger 359* (BO). **Borneo: Kalimantan Timur:** West Koetai, Kombeng, 22 Nov 1925, *Endert, F.H. 5143* (BO, L); West Koetai, Lahren, 29 Jun 1925, *Endert, F.H. 1762* (BO, L); Tanah Grogot, Batu Kajang, Desa Kasungai, 27 Nov 1979, *Ma'roef, A. AM.250* (BO, K); Berau, Sungai Kelai, Gunung Njapa, 18 Oct 1963, *Kostermans, A.J.G.H. 21338* (BO, G, K, L); Berau, Tanjung Redeb, Gunung Buntung, 28 Nov 1981–1 Sep 1981, *Kato, M. et al. B.11733* (BO, KYO); Kenangan, 12 Aug 1979, *Dransfield, J. 4402* (BO). **Kalimantan Selatan:** 1908, *Winkler, H. 2670* (BO, G, K, L); Gunung Serempaka, 26 Nov 1971, *Dransfield, J. & Saerudin, D. 2314* (BO, L); Djaro Dam, 11 Nov 1971, *Kuswata 718* (BO); Muara Uja, 21 Nov 1971, *Dransfield, J. & Saerudin, D. 2268* (BO, K, L). **Sulawesi Selatan:** Bantimurong National Park, 20 Feb 1938, *Buwalda, P. 3761* (BO). **Sulawesi Tengah:** G. Batoe, 1913, *Rachmat 439* (BO); Luwuk, 9 Oct 1989, *Coode, M.J.E. 5855* (K); Soroako-Wasuponda Road, 7 Jul 1979, *van Balgooy, M.M.J. 3922* (L). **Sulawesi Tenggarah:** Pohara, Muara Sampara, 14 Apr 1929, *Kjellberg, G.K. 1299* (BO, S); Pulau Butung, Jismal Camp, 12 Nov 1989, *Coode, M.J.E. 6206B* (K); Pulau Butung, 17 Feb 1929, *Kjellberg, G.K. 195* (S). **Sulawesi Utara:** Bogani Nani Wartabone National Park, 24 May 2002, *Uji, T. 4595* (BO).

Notes. Epithema saxatile is one of the most widely distributed species of *Epithema*. At first it appears that there are a few different forms of *E. saxatile*, one with petiolate upper leaves, one with sessile upper leaves and one with occasional, solitary upper leaves, but all of these can be found within a single population.

Some collections of this species have strongly variegated leaves but this character does not appear to have any taxonomic significance.

17. *Epithema steenisii* Hilliard & B.L.Burtt, Edinburgh J. Bot. 54: 113 (1997). – TYPE: Indonesia, Sumatra, Aceh, Gaju & Alas Lands, Gadjah to Pendeng, 16 February 1937, *van Steenis, C.G.G.J. 8825* (holotype L; isotypes BO (image seen), K, SING). (Fig. 10)

Herb 3–15 cm high, caulescent, indumentum of strigose, setose or hispid hairs; stem 1–2 mm wide with 2–4 nodes, internodes 1–3 cm long. ***Leaves*** strongly membranous, petiolate, occasionally with more than one solitary lower leaf; petioles 0.2–4.5 cm long; blade of lowest leaf 3.2–9 × 1.7–4 cm, upper leaves 1.5–9 × 0.7–4.7 cm, more or less lanceolate, elliptic, or narrowly ovate, upper portion sometimes curved and upper

halves asymmetric, if the blade is asymmetrical, one side up to 1.5 times wider than the other, apex acute to more rarely broadly acute, rarely rounded, base sub-truncate, more rarely cuneate to rounded, inserted evenly on petiole or not, margin variable, weakly serrate to bidentate; upper surface densely strigose to villous, hairs 0.75–1 mm long; lower surface densely pubescent or strigose and setose, hairs to 1.1 mm long. ***Inflorescences*** 2–4 per plant; peduncles 0.5–10.5 cm long, arising from leaf axils; ***bracts*** cucullate, often completely enclosing inflorescence, 9–23 × 5–12 mm, margin dentate, teeth small, lower surface strigose, hairs to 0.6 mm long, upper surface glabrous or sub-glabrous; pedicels 1.5–3.6 mm long, often with only strigose hairs to 0.5 mm long, but sometimes also with additional minute hairs. ***Calyx*** 3.5–5 mm long; tube 2–3 × 1.2–2.3 mm, 1–2 times as long as wide, lobes 1.5–2.7 × 0.6–1.5 mm; outside sparsely to densely strigose, hairs straight, occasionally hooked, 0.5–0.8 mm; glabrous inside. ***Corolla*** white or pale lilac to lilac, 6.7–9 mm long; tube 4–6.5 × 1–1.5 mm; lobes 2.5 × 1 mm. ***Stamen*** filaments c. 1.2 mm long; anther characters unknown; staminodes c. 1.2 mm long. ***Nectary*** of two discrete lobes, c. 0.8 mm high. ***Ovary*** sub-cylindrical, c. 0.9 × 0.8 mm, sub-glabrous to densely pubescent, hairs hooked, 0.05 mm long and placed on upper portion of ovary; style 3.7–4.6 mm long, glabrous or sub-glabrous, hairs at base of style. ***Fruit*** obovate to cylindrical, 1.4–2.3 × 1.7–2.3 mm; operculum 0.5–0.8 mm, sub-glabrous to sparsely pubescent, as ovary. ***Seed*** sub-cylindrical or narrowly to broadly ovoid, the ends often only slightly constricted, 0.3–0.6 × 0.1–0.3 mm, dark brown, pattern straight to spiralled and reasonably regular.

Distribution. Indonesia (Aceh).

Habitat and ecology. Shaded areas, on and among wet (mossy) rocks and in wet sand by streams and rivers at 200–600 m altitude. Flowering and fruiting February, March, May, June, August.

Provisional IUCN conservation assessment. Vulnerable VU D2. This species is only known from the Indonesian province of Aceh in northern Sumatra and many of the populations are from Gunung Leuser National Park. The species is only known to occur below 600 m altitude and Gunung Leuser has been subjected to continued deforestation despite being a "protected" area (Barber et al., 2002).

Additional specimens examined. INDONESIA: **Aceh:** Between Lau Simerah and Lau Penanggajan, 20 Mar 1954, *Alston, A.H.G. 14535* (A); Gaju & Alas Lands, Pendeng-Bivouac Aer Putih Waterfall, 17 Feb 1937, *van Steenis, C.G.G.J. 8879A* (BO, L); Gunung Leuser Nature Reserve, Camp Simpang, 18 Aug 1972, *de Wilde, W.J.J.O. & de Wilde-Duyfjes, B.E.E. 14353* (BO, K, L, US); Gunung Leuser Nature Reserve, Lau Alas Valley, Ketambe, 21 May 1972, *de Wilde, W.J.J.O. & de Wilde-Duyfjes, B.E.E. 12238* (BO, L); Ketambe, Alas River, 9 Jun 1979, *de Wilde, W.J.J.O. & de Wilde-Duyfjes, B.E.E. 18042* (BO, K, L).

Notes. This species is very similar to *Epithema tenerum* from Sulawesi but can be distinguished by the difference in the indumentum on the outside of the calyx. In

addition the cucullate bract usually encloses the inflorescence in *Epithema steenisii* whereas this is variable in *E. tenerum*. See further discussion in the notes section of *Epithema tenerum*.

18. *Epithema strigosum* (C.B.Clarke) Hilliard & B.L.Burtt, Edinburgh J. Bot. 54: 113 (1997). – *Epithema brunonis* var. *strigosum* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 179. (1883). – TYPE: Indonesia, Sumatra, Gunung Singgalan, *Korthals, P.W. 692* (lectotype L, designated by Hilliard & Burtt (1997) [see also note below]). (Fig. 10)

Herb 6–20 cm high, acaulescent or with first leaves arising from a very short stem; stem 2–4 mm wide with 0–1 nodes, internodes 0–1.5 cm long. ***Leaves*** membranous to strongly membranous, petiolate, one lower solitary leaf and one upper, or several leaves in short-stemmed tuft; petioles 0.5–21 cm long; blade 1–19 × 0.5–15 cm, cordate to elongate ovate, symmetrical or not, apex acute, base cordate, sub-auriculate or rounded, inserted evenly on petiole or not, margin crenate or dentate, teeth wide at base and mostly with rounded tips; both surfaces with hairs to 0.8 mm long. ***Inflorescences*** 1–4 per plant; peduncles 6.5–23.5 cm long, originating opposite solitary leaves or at base of petioles; ***bracts*** cucullate, completely enclosing the inflorescence, 14–18 × 8–15 mm, margin entire to dentate, lower surface setose and strigose, hairs medium density, to 0.4 mm long, upper surface glabrous to strigose, hairs to medium density, primarily straight or straight and hooked, to 0.4 mm long; pedicels 1.7–5(–7.5) mm long, finely densely pubescent, hairs hooked, also with or without sparse straight hairs 0.1–0.4 mm long. ***Calyx*** 3.1–5.2 mm long; tube 1.7–4.2 × 1.5–2.7 mm, lobes 1.5–2.3 × 0.8–1.7 mm; sparsely setose and strigose outside, hairs primarily hooked or both straight and hooked, white, to 0.4 mm long, covering calyx; inside with hairs throughout to only on lobes, hairs straight or both straight and hooked, to 0.13 mm long. ***Corolla*** white, 4.5–8.3 mm long; tube 3.7–5 × 1.5 mm; lobes 0.8–3.3 mm long; margin slightly fimbriate; a partial or complete band of villous hairs in upper half inside. ***Stamens*** 2.1–2.4 mm long; filaments 1.5–1.8 mm long; anthers c. 0.6 mm long; staminodes 1.2–1.7 mm long. ***Nectary*** of one or two lobes, 0.5–0.3 mm long. ***Ovary*** 0.8–1 × 0.7–0.8 mm, densely pilose, hairs straight, white, 0.1–0.3 mm long, placed on upper portion of ovary; style 3.5–4.6 mm long, glabrous or sparsely pubescent at base of style, hairs straight; stigma c. 0.5 mm wide. ***Fruit*** cylindrical to spherical, 1.5–1.9 × 1.1–2.3 mm; operculum c. 0.6 mm long, pubescence as on ovary. ***Seed*** ovoid, sometimes somewhat curved, 0.4–0.5 × c. 0.1 mm, light to medium brown, pattern almost straight to spiralled, regular.

Distribution. Indonesia (Sumatra).

Habitat and ecology. Lithophytic. Found in shaded, humid areas beside rivers and streams and along paths at 100–1000 m altitude. Flowering and fruiting January–March, August.

Provisional IUCN conservation assessment. Endangered (EN B1ab(iii)). This species has a restricted distribution in West Sumatra in areas subject to continuing degradation of natural habitats.

Additional specimens examined. INDONESIA: **Sumatera Barat:** Kabupaten Padang Pariaman, Sipisang, 9 Jan 1995, *Okada, H. et al. 1343* (BO); Gunung Singgalan, Singalang, *Korthals, P.W.* s.n. (L); Mt Sago, 9 Mar 1957, *Meijer, W. 5637* (L); Padang, Indarung, K. Putih, 16 Feb 1981, *Hotta, M., Okada, H. & Kohyama, T. 319* (KYO); Padang, Indarung, Ladang Padi, K. Putih, 8 Aug 1984, *Hotta, M. & Okada, H. 1087* (KYO); ibidem, 14 Aug 1981, *Hotta, M. & Okada, H. 516* (KYO); Padang, Ladang Padi, 28 Aug 1984, *Hotta, M., Okada, H. & Kohyama, T. 689* (KYO, L); Padang, Ulu Gadut, 10 Jan 1983, *Hotta, M., Okada, H. & Ito, M. 402* (KYO); Padang, Ulu Gadut, Sungai Gadut Gadang, 2 Aug 1984, *Hotta, M., Okada, H. & Kohyama, T. 324* (KYO); ibidem, 2 Aug 1984, *Hotta, M., Okada, H. & Kohyama, T. 339* (KYO).

Notes. *Epithema strigosum* is most similar to *E. philippinum* but differs from *E. philippinum* in the larger calyx, the lack of a minute pubescence on the outside of the calyx and the larger hairs only being sparse, the pubescence inside the calyx is less dense, the leaf margin is crenate rather than dentate or serrate, the corolla can be longer (4.5–8.3 mm long rather than 5–6 mm long) and is reportedly white rather than blue. *Epithema strigosum* is only found in Sumatra and *E. philippinum* only in the Philippines. All specimens of *Epithema strigosum* are from an area of limestone east of Padang.

Korthals s.n. (L0796748) is possibly a duplicate of *Korthals 692*, the type collection, but has no field number, only a herbarium number of 113 which is also on the lectotype. The plants are very similar and could be the same collection.

19. *Epithema tenerum* (C.B.Clarke) Hilliard & B.L.Burtt, Edinburgh J. Bot. 54: 113 (1997). – *Epithema brunonis* var. *tenerum* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 180 (1883). – TYPE: Indonesia, Sulawesi, South Sulawesi, Maros, *Zollinger, H. 1172* (lectotype G, designated here; isolectotypes L, P). (Fig. 6, 13)

Herb 5–14(–20) cm high, caulescent; stem 0.8–2 mm wide with 2–3 nodes, internodes 0.5–5(–10) cm long. ***Leaves*** thinly membranous to membranous, petiolate, upper leaves opposite or sub-opposite; petiole of lowest leaf 1–5 cm long, upper petioles 0.2–5 cm long. Blade of the lowest leaf 2.3–12 × 1.4–8 cm, upper leaves 1.9–10 × 0.9–5 cm, leaves usually broadly lanceolate to narrowly ovate or elliptic, but occasionally broadly ovate or obovate to broadly obovate, symmetrical or not, if asymmetrical one side up to 1.4 times wider than the other, apex acute to broadly acute, base sub-cordate, sub-truncate or obtuse, inserted evenly on petiole or not, margin entire to weakly serrate; upper surface primarily strigose, hairs straight, medium density, to 0.7 mm long; lower surface may dry grey-green, sub-glabrous to pubescent, hairs medium density, to 0.4 mm long, veins raised with distinct, sparsely to densely pubescent, primarily strigose hairs, to 0.6 mm long. ***Inflorescences*** 1–6 per plant; peduncles 0.3–7(–18) cm long, originating from the terminal and lower axils; ***bracts*** small, sub-cucullate or cucullate,

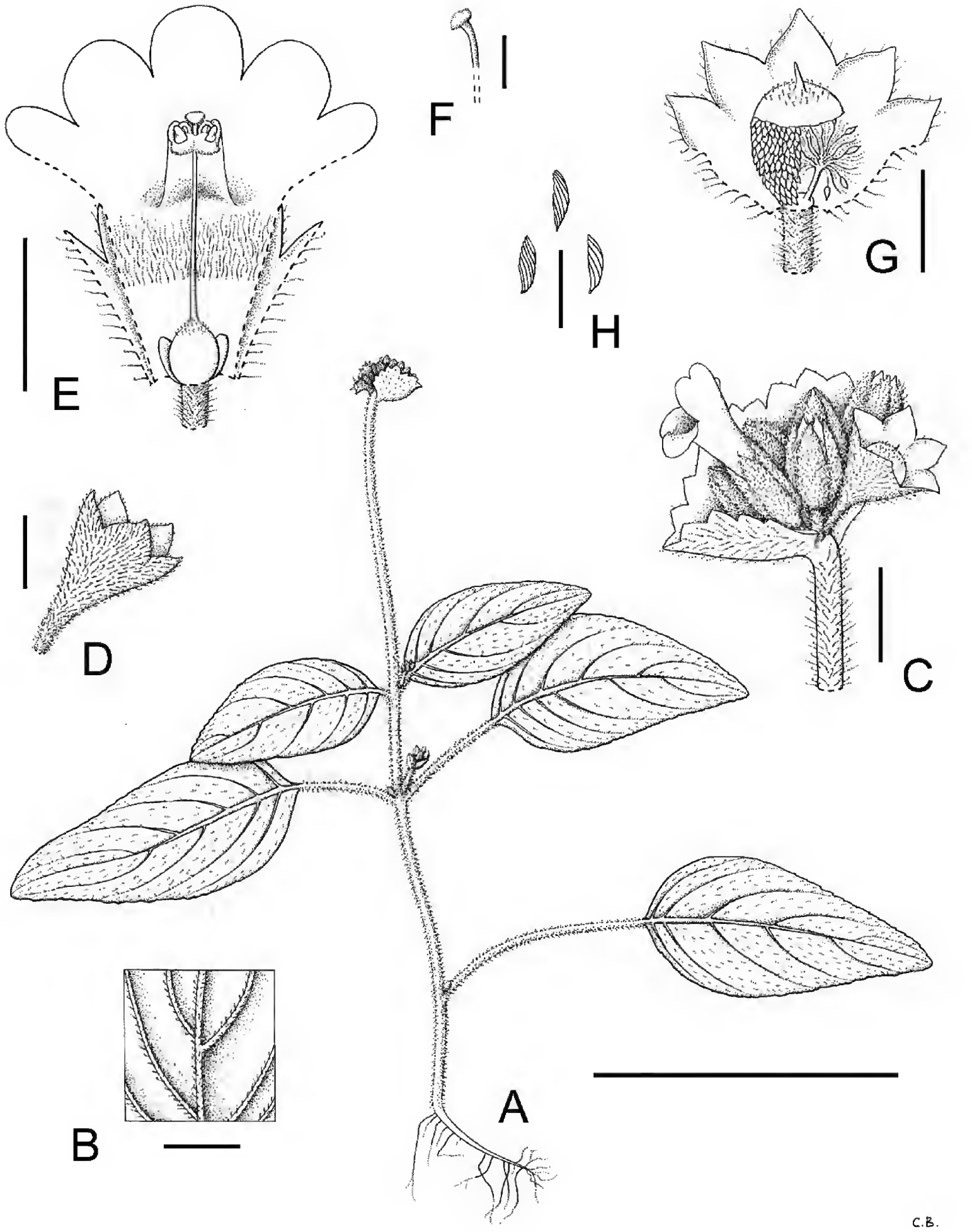

Fig. 13. *Epithema tenerum* (C.B.Clarke) Hilliard & B.L.Burtt. **A.** Habit. **B.** Underside of leaf. **C.** Inflorescence. **D.** Calyx. **E.** Flower opened out. **F.** Stigma lateral view. **G.** Fruit showing seeds, placenta and operculum. **H.** Seeds. Scale bars: A = 4 cm; B = 5 mm; C, E = 3 mm; D, G = 2 mm; F = 1 mm; H = 0.5 mm. Drawn by Claire Banks from *Zollinger 1172* (A), *Zollinger 1064* (B), *P.C. Thomas and W. H. Aroli 09-74* (C–G), *Jaag 1600* (H).

6–16 × 3–7 mm, undulate to lobed with occasional dentation or dentate; lower surface strigose, hairs straight, to medium density and 0.5 mm long; upper surface glabrous or sub-glabrous; pedicels 0.8–3.3 mm long, finely pubescent hairs to 0.13 mm long, also with or without straight, strigose hairs to 0.5 mm long. ***Calyx*** occasionally tinged purple, 1.7–3.4 mm long; tube 0.9–2.5 × 0.9–2.5 mm; lobes 0.6–1.5 × 0.6–1.9 mm; sub-glabrous, strigose or setose outside, also with minute, hooked hairs, hairs medium density, straight hairs to 0.5 mm long, hooked hairs to 0.3 mm long; glabrous inside. ***Corolla*** blue, pale-blue or pale purple, 5.2–6 mm long, tube 4–4.8 × 0.8–1.3 mm; lobes 0.9–1.8 × 1–2.1 mm, margins entire to slightly crenate, dense band of villous hair inside. ***Stamen*** filaments c. 1.5 mm long; anther characters unknown; staminodes c.1.25 mm long. ***Nectary*** usually of two discrete lobes (occasionally one), margin entire, 1 × 0.75–1.5 mm. ***Ovary*** sub-cylindrical, 0.8–0.9 × 0.6–0.75 mm, with hooked hair on upper half of ovary, hairs to densely pubescent, c. 0.1 mm long; style c. 3.3 mm long, glabrous; stigma up to c. 0.5 mm wide. ***Fruit*** sub-spherical, 1.6–2.1 × 1.9–2.2 mm, operculum 0.6–0.8 mm long, indumentum as ovary. ***Seed*** narrowly ovoid to ovoid, 0.4–0.5 × 0.1–0.2 mm, light to medium brown, pattern sub-erect to spiralled, reasonably even.

Distribution. Indonesia (Sulawesi).

Habitat and ecology. Lithophytic, often found directly on limestone or on rocks of unknown type at 20–750 m altitude. Usually beside streams and waterfalls but also on road sides and on rock walls.

Provisional IUCN conservation assessment. Vulnerable (VU D2). This species is only known from a small number of localities and these mostly karst limestone, a habitat which is frequently exploited for cement and tourism.

Additional specimens examined. INDONESIA: **Sulawesi Utara:** Bolaang Mongondow, Dumoga Bone National Park, Edwards Camp, 26 Mar 1985, *de Vogel, E.F. & Vermeulen, J.J. 6759* (L); Maros, *Zollinger, H. 1064* (A, P). **Sulawesi Selatan:** Bantimurung, 16 Jun 1938, *Jaag, O.1600* (L); ibidem, 20 May 1929, *Rant, A. 40* (BO); ibidem, 20 Feb 1938, *Buwalda, P. 3671* (L); ibidem, 20 Feb 1938, *Buwalda, P. 3677* (BO, L); ibidem, 13 Apr 1975, *Meijer, W.9133* (BO, L, US); Bantimurung, Bantimurung Waterfall, 15 Apr 2009, *Thomas, D. & Ardi, W.H. 09–74* (E); Pankadjene, 8 May 1931, *Teruya, Z. 1848* (SING). **Sulawesi Tenggara:** Kesali-Porema, 23 Oct 1929, *Kjellberg, G.K. 2618* (BO, S).

Notes. This species is most similar to *Epithema steenisii* from Aceh, Sumatra. It differs mainly in the type of calyx hair, the density of the leaf hair and the length of the corolla. On the calyx there are small, hooked hairs in addition to the longer, straight hairs which are present in both *Epithema tenerum* and *E. steenisii*. In addition, the longer hairs are generally shorter in *Epithema tenerum* than in *E. steenisii* (to 0.5 mm vs. to 0.8 mm long). The hair on the upper surface of the leaves is usually much less dense in *Epithema tenerum* than in *E. steenisii* and the corolla tube is 4–4.8 mm and 4–6.5 mm respectively.

Epithema tenerum usually follows the general *Epithema* pattern of having one larger, lower leaf and one or more pairs of opposite, upper leaves. Some upper leaf pairs are actually sub-opposite and this is most clearly seen in the larger specimens (eg. *Teruya* 1848 (SING)).

The species has been collected from few localities in Sulawesi, principally from Bantimurung in the south-west of the island. The specimens from northern Sulawesi, *De Vogel* and *Vermeulen 6759* (L) and, in particular, *Kjellberg 2618* (S), are generally larger than those from Bantimurung. The multi-specimen sheet from Pankadjene, *Teruya 1848* (SING), in southern Sulawesi, however, has plants spanning the entire size range.

20. *Epithema tenue* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 181 (1883). – TYPE: Equatorial Guinea, Bioko, 1863, *Mann, G. 2345* (lectotype K, designated here; isolectotype P). (Fig. 14, 15)

Epithema thomense Henriq., Bol. Soc. Brot. 10: 145 (1892). – TYPE: Sao Tome and Principe, Sao Tome, May 1888, *Quintas, F. 1272* (lectotype COI, designated here; isolectotype K).

Epithema graniticolum A.Chev., Bull. Soc. Bot. France 58 (Mem. 8d.): 189 (1912). – TYPE: Guinea, Montagne de Boola, Pays de Guerzes, 1048 m, 16 March 1909, *Chevalier, A.J.B. 20924* (lectotype P, designated here).

Herb 5–40 cm high, acaulescent or caulescent, occasionally the plant is of only one leaf; stem 1–5 mm wide with 1–3 nodes, internodes 1–16.5 cm long. ***Leaves*** membranous or strongly membranous, lower leaves petiolate, upper leaves petiolate and/or sessile or occasionally with a solitary, upper leaf opposite peduncles; petiole of lowest leaf 2–10 cm long, upper petioles 0.2–8 cm long; blade of lowest leaf 6.5–24 × 4.5–19 cm, upper leaves 2–10 × 1.5–8.4 cm, the lowest leaf very large and almost oblong to broadly ovate, ovate or cordate, upper leaves ovate to broadly elliptic or spherical, symmetrical or not, apex often rounded but also acute, base cordate or sub-cordate, inserted evenly on petiole or base of upper leaves with one side truncate or obtuse and the other cordate, margin variable, often sub-entire or minutely serrate or dentate, but also serrate, dentate or crenate (usually the upper leaves); upper surface weakly strigose or strigose, hairs to medium density, to 1.5 mm long; lower surface strigose to medium density, 0.5–0.8 mm long, and pubescent with minute, hooked hairs to 0.1 mm long. ***Inflorescences*** 1–6 per plant; peduncles 0.5–14 cm long, originating from the base of the stem, opposite the solitary lower leaf or from the terminal axil; ***bracts*** frequently very large, cucullate and enclosing the inflorescence but may be small and enclosing a small proportion of the inflorescence, 4–40 × 5–14 mm, margin dentate or entire; lower surface weakly strigose or strigose, hairs 0.2–0.8 mm long; upper surface glabrous or sub-glabrous, hairs straight and concentrated towards margins; pedicels 0.8–4 mm long, weakly strigose, hairs to medium density and 0.8

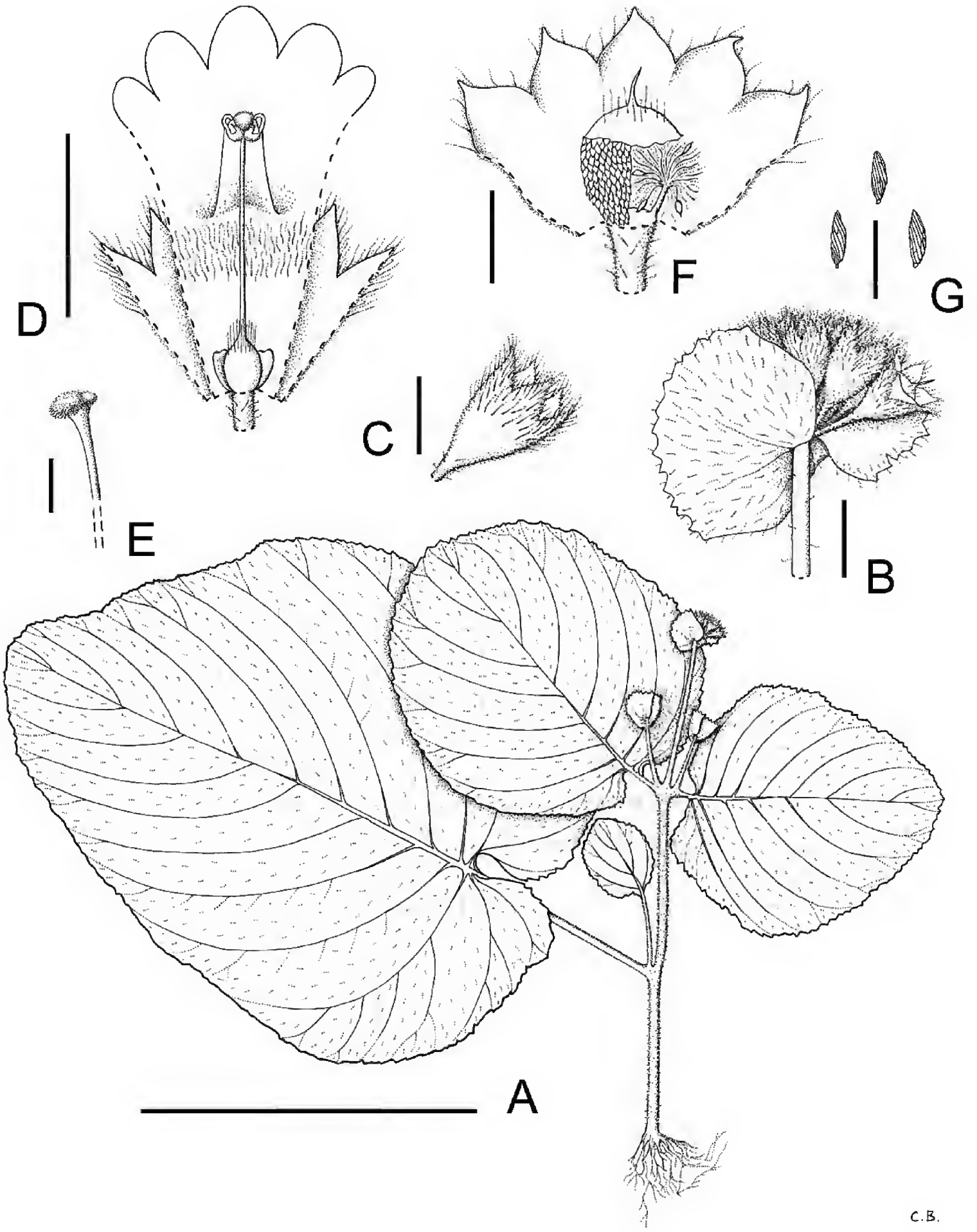

Fig. 14. *Epithema tenue* C.B.Clarke. **A.** Habit. **B.** Inflorescence. **C.** Calyx. **D.** Flower opened out. **E.** Stigma lateral view. **F.** Fruit showing seeds, placenta and operculum. **G.** Seeds. Scale bars: A = 10 cm; B = 5 mm; C, F = 3 mm; D = 6 mm; E = 1 mm; G = 0.5 mm. Drawn by Claire Banks from *Letouzy 7722* (A, B), *Letouzy 13973* (D, E) and *Sita 2886* (C, F, G).

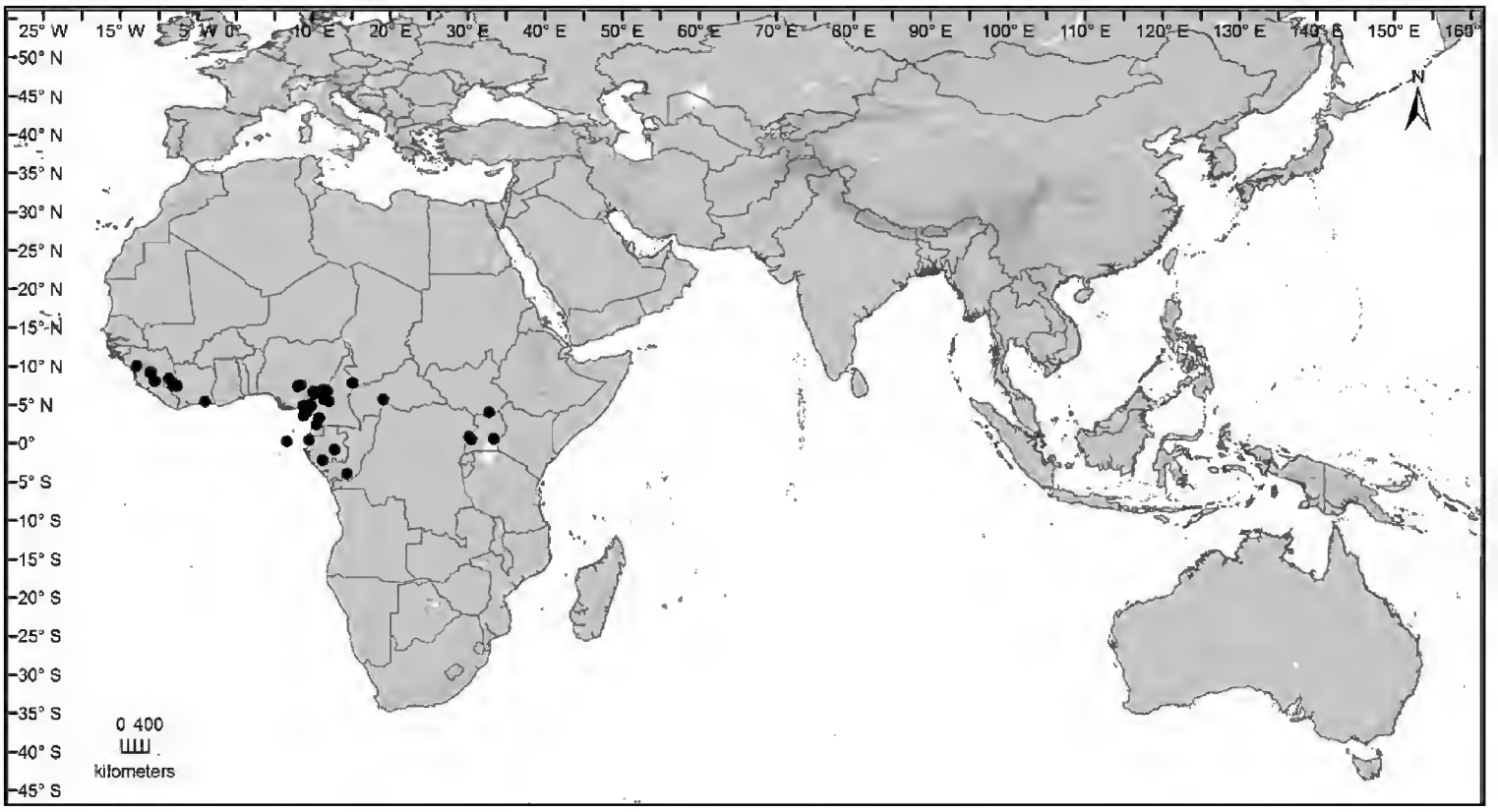

Fig. 15. Distribution of *Epithema tenue* C.B.Clarke (●).

mm long, also hooked hairs to medium density and 0.1 mm long. ***Calyx*** 2–8 × 1.3–2 mm; tube 1.3–4 mm long; lobes 0.8–3.8 mm long; with long hairs usually villous, or occasionally to glabrous or sub-glabrous in maturity, hairs to high density, especially in young flowers, hyaline, 0.6–1.5 mm long; glabrous inside. ***Corolla*** blue-purple, tube white, 9.6–10.5 mm long; tube 6.6–7.5 × 2 mm; lobes c. 3 mm long; a band of villous hairs inside, hairs at half to two-thirds the way up the tube. ***Stamens*** 2–2.5 mm long; filaments 1.5–2 mm long; anthers c. 0.5 mm long; staminodes 1.5–2 mm long. ***Nectary*** usually apparently absent, but also of one or two lobes, sometimes reduced, 0.6–1 × 0.8–1.3 mm, margin undulate or entire. ***Ovary*** ovoid, spherical or cylindrical, 0.8–1.5 × 0.6–1.3 mm, weakly hirsute to villous with hairs straight, 0.5–1.5 mm long, with or without additional hooked hairs to 0.1 mm long (often seen most easily on the fruit operculum); style 6 mm long, glabrous or one or two hairs at base, hair to 0.08 mm long; stigma c. 0.5 mm wide. ***Fruit*** sub-cylindrical to sub-spherical, 1.5–3 × 1.5–3 mm; operculum 0.5–1 mm long, indumentum as on ovary. ***Seed*** narrowly ovoid to ovoid, 0.4–0.5 × 0.1–0.2 mm, medium brown, pattern sub-erect or erect, reasonably even.

Distribution. Guinea, Sierra Leone, Liberia, Ivory Coast, Nigeria, Cameroon, Equatorial Guinea, Gabon, Sao Tome and Principe, Democratic Republic of Congo, Uganda, South Sudan.

Habitat and ecology. Primarily lithophytic, often on granite at 180–1100 m altitude. Found in humid areas, typically in shade, usually on or near rocky areas, in or beside streams, waterfalls or cave entrances. Also found beside paths and highways. Flowering and fruiting year round.

Provisional IUCN conservation assessment. Least Concern (LC). This is a widespread species not known to be under any immediate threats.

Additional specimens examined. GUINEA: Kindia, *Jacques-Félix, H.* s.n. (P).
SIERRA LEONE: Between Kurubonla and Seredu, 15 Nov 1965, *Morton, J.K. SL2530* (E, K); Loma Mountains, Oct 1944, *Jaeger, P. 227* (K).
LIBERIA: Kolahun, Vahon, 7 Nov 1947, *Baldwin, J.T. 10215* (K, US).
IVORY COAST: *Chevalier, A.J.B. 21418* (K, P); *Chevalier, A.J.B. 21506* (P); Banco, 11 Apr 1979, *Knedl, M. 721* (G); Gueoule, 3 Feb 1984, *Hepper, F.N. & Maley, J. 8073* (K); Haut Nuon, *Chevalier, A.J.B. 21141* (P); Haut Sassandra, Droupleu to Zoanle, 5 May 1909, *Chevalier, A.J.B. 21457* (P); Man, Mt Tankoui, 4 Jul 1966, *Ake Assi, L. 9043* (G); ibidem, Aug 1978, *Knedl, M. 9/365* (G); Tiapleu, 25 Sep 1955, *Unknown 3296* (P).
NIGERIA: Gongola, Mambilla, River Nwum Forest Reserve, 30 Jun 1976, *Chapman, J.D. 4505* (K); Sarduna, Gembu, Kamatan Forest Reserve, 14 Dec 68, *Daramola, B.O. FHI62313* (K).
CAMEROON: Bamenda Province, Bamenda District, Metschum Falls, 26 Aug 1952, *Savory, H.J. UCI299* (K); Bamenda Province, Wum, Nbika's By-Pass, 28 Jun 1951, *Ujor, E. FHI29260* (K); Banyo, Tako-Atta Manga, 5 Jul 1967, *Letouzey, R. 8732* (P); Collines a 5km au SW d'Ebianeme-Yong pres Nyabessan, 10 Apr 1968, *Letouzey, R. 9238* (P); Ga Village, Pagan Hill, 29 Aug 1966, *Letouzey, R. 7722* (COI, K, P); Lolodorf, 15 Jun 1918, *Annet, E. 337* (K, P); Muyuka, Munyenge, 29 May 1976, *Letouzey, R. 15020* (P); Muyuka, Munyenge, Mt Cameroun, 29 May 1976, *Letouzey, R. 15026* (K, P); Nkambe, Vallen Forest, 12 Nov 1974, *Letouzey, R. 13198* (P); Northern Cameroon, Munkep, Essu-Munkep Trail, 7 Jul 1975, *Letouzey, R. 13973* (P); South West Province, Etinde, Upper Boando, Upper Boando Village, 1 Dec 1993, *Cable, S. 283* (K); South West Province, Fako, Buea, Likombe, 2 Sep 1992, *Nkeng, P. 90* (K); South West Province, Kupe-Muanenguba Division, Kupe Village, 27 May 1996, *Etuge, M. 1973* (K); ibidem, 10 Jul 1996, *Kenfack, D. 259* (K); ibidem, 15 Jul 1996, *Zapfack, L. 929* (K); South West Province, Kupe-Muanenguba Division, Ngomboku, 10 Dec 1999, *Mackinder, B.A. 303* (K); South West Province, Kupe-Muanenguba Division, Nyale, 17 Nov 1988, *Cheek, M.R. et al. 9647* (K); South West Province, Kupe-Muanenguba Division, Nyasoso, 24 Jun 1996, *Cable, S. 3256* (K, WAG, YA); ibidem, 19 Dec 1993, *Cable, S. & Ajebe, E.F. 644* (K); ibidem, 2 Jun 1996, *Etuge, M. 2057* (K); ibidem, 19 Oct 1995, *Sidwell, K. et al. 305* (K); South West Province, Kupe-Muanenguba Division, Nyasoso, Mount Kupe, 7 Feb 1996, *Cable, S. 3532* (K, YA); ibidem, 7 Oct 1998, *Harris, D. 5815* (E); ibidem, 23 Oct 1995, *Sebsebe Demissew 4984* (K); ibidem, 7 Jul 1992, *Wheatley, J.I. 4117* (K); ibidem, 2 Jun 1996, *Zapfack, L. 597* (K); South West Province, Meme, Nyasoso, 23 Jun 1996, *Cable, S. 3208* (K); South West Province, Meme, Nyasoso, Mt Kupe, 5 Aug 1993, *Balding, S. & Sivell, D. 37* (K); ibidem, 19 Sep 1992, *Cable, S. 19* (K).
EQUATORIAL GUINEA: Bioko, 16 Jan 1947, *Guinea, E. 1408* (K); Bioko, Basile, 30 Aug 1990, *Carvalho 4464* (K); ibidem, 29 Jul 1986, *Carvalho 2130* (K).
GABON: 13 Mar 1925, *Le Testu, M.G. 5449* (P); Lastoursville, 1929–1931, *Le Testu, M.G. 7018* (K); Libreville, 2 Feb 1899, *Klaine, R.P. 1517* (K); ibidem, *Klaine, R.P. 2666* (P); Ndende, 22 Nov 1983, *de Wilde-Dujfjes, B.E.E. et al. 745* (K).
SAO TOME AND PRINCIPE: St Thome, *Henriques, J.A.* 5 (K); ibidem, *Henriques, J.A. 12* (K).
DEMOCRATIC REPUBLIC OF CONGO: Meya, Camp O.R.S.T.O.M., 12 Feb 1969, *Sita, P. 2886* (P).

UGANDA: 1906, *Bagshawe, A.W.G. 1282* (US); Bundibugyo, Sempaya Hot Springs, 14 Sep 1997, *Lye, K.A. & Katende, A.B. LYE22885* (K); Bwamba, Balanga, 22 Nov 1935, *Thomas, A.S. Th.1529* (K); Bwamba, Bulanga, 30 Sep 1932, *Thomas, A.S. Th.729* (K); Lake Albert Edward, 1906–1907, *Bagshawe, A.W.G. 1376* (US).
SOUTH SUDAN: Imatong Mountains, Talanga, 26 Nov 1980, *Friis, I. & Vollesen, K.B. 462* (C, K).

Notes. There are two forms of *Epithema tenue*, an acaulescent and a caulescent form. The acaulescent form is found in the Central African Republic, Equatorial Guinea (Bioko), Cameroon and Gabon while the caulescent form is found in the Ivory Coast, Nigeria, Sudan, Uganda, Liberia, Guinea, Sierra Leone, Cameroon and Gabon. In only Cameroon and Gabon are there collections of both forms. The acaulescent form has, primarily, big bracts and inflorescences and calyces which are pubescent with long hairs. The size of the inflorescence is more variable in the caulescent form, but can be still large and pubescent. The duplicates of *Harris 5815* (E) from Cameroon show the acaulescent and caulescent forms can be found within one population. In this collection the acaulescent specimens are small and membranous and have small bracts and inflorescences but still have the characteristic long, straight hair on the ovary/ operculum.

Some of the caulescent specimens could be mistaken for *Epithema carnosum*. They differ from *E. carnosum* by the size of the bract and calyx and the dense indumentum on the outside of the calyx. Some, however, have small bracts, inflorescences and calyces, and the indumentum is sparse. These can still be separated using the length of the hair on the operculum. While this hair is straight in both species, in *Epithema tenue* it is from 0.5–1.5 mm long and in *E. carnosum* it is from 0.08–0.25 mm long. There are a small number of specimens that are not readily differentiated from *Epithema carnosum* as the indumentum on the ovary is short. While it is sparse, the indumentum of the calyx of these specimens is that of *E. tenue*, being hyaline, villous and long instead the hyaline to white, short and more strigose hair of *E. carnosum*. As these two species occur on different continents confusion between the two should not be a problem.

Excluded Species

Epithema triandrum (Blanco) Fern.-Vill., Nov App. 150. (1880). – *Ophiorrhiza triandra* Blanco, Fl. Filip., ed. 2 [F.M. Blanco] 65 (1845). = ***Ophiorrhiza oblongifolia*** DC. (see Merrill, 1918).

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Sabli, J. et al. S.89048 (15); *Sakol 1150* (3); *Saldanha, C.J. 14426* (3); *Sands, M.J.S. 6141* (1), *6318* (1), *6337* (1), *6841* (1); *Sands, M.J.S. & Young, R.G.N. SANDS3936* (16); *Sangkhachand, B. 1405* (10); *Santisuk, T. & B.N. 451* (10); *Savory, H.J. UCI299* (20); *Saw, L.G. FRI39945* (10); *Schiffner, V.F. 2567* (16); *Schmutz, E. 2127* (8), *3208* (8), *3623* (5), *4027* (5), *4345* (5), *4732* (5); *Schram, F.A.W. BW10631* (1), *BW13259* (1); *Scortechini 1580* (16); *Scott 3* (2); *Sebsebe Demissew 4984* (20); *Sharma, B.D. 42032* (3); *Shimizu, T. et al. T.18519* (3), *T.19413* (3), *T.20909* (2), *T.27111* (16), *T.27551* (16), *T.27571* (16), *T.28985* (16), *T.27111* (16), *T.27100* (16), *T.27103* (16), *T.27551* (16), *T.28519* (3); *Shimizu, T. et al. T.10789* (3), *T.29151* (16); *Shimizu, T. & Fukuoka, N. M.14143* (16); *Shimizu, T. & Stone, B.C. 13739* (11), *14427* (10); *Sidwell, K. et al. 305* (20); *Sinclair, J. 7821* (11), *9846* (16); *Sirute'e, B. et al. BSIP9621* (14); *Sita, P. 2886* (20); *Smith, H.C. 16273* (2); *Smitinand, T. 3489* (16), *4719* (3); *Smitinand, T. & Abbe, E.C. 6149* (16); *Smitinand, T. & Sleumer, H.O. 1006* (3), *1109* (3), *1207* (16); *Sorensen, T. et al. 4235* (3), *4936* (3); *Spanoghe, J.B. 226* (6); *Staples, G.W. et al. 1409* (3); *Stocks s.n.* (13); *Stocks, Law & co. s.n.* (3); *Stone, B.C. et al. 870424-5/1* (10); *Stone, B.C. 8830* (11), *13730* (15); *Stone, B.C. & Anderson, E.F. SAN86719* (4); *Stone, B.C. & Mahmud 8400* (11); *Subba Rao, G.V. 28210* (2); *Subramanyam, K. 8644* (3), *8975* (3); *Sugau, J. JBS96* (15); *Sukendar SK740* (1); *Sulit, M.D. & Conklin, H.C. 16913* (3); *Sumadijaya, A. AX360* (16); *Sumathi, R. 17895* (3); *Sumithraarachchi, D.B. DBS388* (3); *Sutheeson, S. 2489* (16), *5004* (16); *Suvanakoses, P. 1727* (10), *2060* (3); *Symington, C.F. & Agama, J. 9361* (4); *Synge, P.M. S.634* (15), *S.565* (15).

Tagawa, M. et al. T.11259 (16); *Tamura, M. & Hotta, M. 602* (16), *690* (4); *Teijsmann, J.E. s.n.* (7); *Teruya, Z. 1848* (19); *Theobald, W.L. & Grupe, D.A. 2368* (3), *2404* (3); *Thomas, A.S. Th.729* (20), *Th.1529* (20); *Thomas, D. & Ardi, W.H. 09-74* (19); *Thomson, G.*

s.n. (3), *121* (3); *Thomson, T. s.n.* (2); *Thorel, C. s.n.* (16); *Thwaites, G.H.K. 2844* (3); *Toxopeus, F.J. 358* (1); *Turner, I.M. & Yong 158* (10).

Uji, T. 4595 (16); *Ujor, E. FHI29260* (20); *Unknown s.n.* (3), *147* (11), *208* (16), *226* (6), *654* (16), *753* (3), *2648* (16), *3296* (20), *3847* (2), *12200* (2); *Unknown (ex Herb. Lugd. Batav.a) s.n.* (5).

Vajvavelu, E. 27558 (3); *van Balgooy, M.M.J. 3600* (1), *3922* (16), *4712* (1), *4889* (7), *5066* (7); *van Borssum Waalkes, J. 3025* (6); *van der Pijl, L. 205* (16); *van Niel, J.P. 3554* (15); *van Pruk, L. 350* (3); *van Royen, P. 4946* (1), *5063* (1); *van Steenis, C.G.G.J. 616* (16), *3925* (16), *5734* (16), *7788* (5), *8825* (17), *8879 p.p.* (16), *8879A* (17), *9267* (16), *11079* (5); *Verheijen, J.A.J. 3070* (8), *3323* (8); *Vermeulen, J.J. 1188* (16), *2037* (16); *Versteegh, C. BW7405* (1), *BW12694* (1); *Vink, W. BW12141* (7).

W. C. 2680 (3); *Waas, S. 1407* (3); *Wallich, N. 9080* (10); *Walsh, M.E. 62* (8); *Weber, A. 860809-1/1* (16); *Weber, C.M. 1440* (1); *Wenzel, C.A. 231* (1), *437* (1); *Wheatley, J.I. 4117* (20); *Wight, R. 1/162* (3), *556* (3), *2350* (3); *Wilkie, P. et al. PW764* (16); *Wilkie, P. FRI52899* (10); *Williams, K. et al. 1400* (16), *2033* (16); *Williams, R.S. 937* (3), *2046* (1), *2401* (1); *Winkler, H. 2670* (16); *Wirawan, N. 45* (16); *Wolff, T. 3004* (14), *3025* (14); *Wongprasert, T. 9912-30* (16); *Wright, E. & Chai, P. S.27457* (16).

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Synoptic overview of *Acacia* sensu lato (Leguminosae: Mimosoideae) in East and Southeast Asia

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ABSTRACT. Recent research shows that the formerly broadly circumscribed, pantropical genus *Acacia* Mill. (Leguminosae: Mimosoideae) is polyphyletic and should be treated as comprising at least five genera, namely, *Acacia* Mill. sensu stricto, *Acaciella* Britton & Rose, *Mariosousa* Seigler & Ebinger, *Senegalia* Raf. and *Vachellia* Wight & Arn. The indigenous flora of *Acacia* sensu lato in East and Southeast Asia comprise 52 species: 32 species (38 taxa) of *Senegalia*, 12 species of *Acacia* sensu stricto and eight species of *Vachellia*. These species are listed and their geographic distributions given, showing that *Acacia* sensu lato is unevenly distributed across the region, with centres of species-richness in Indonesia, Myanmar and Thailand. A summary of the classification history of *Acacia* sensu lato is provided and nomenclatural impacts of the recent retypification of *Acacia* briefly discussed.

Keywords. Classification, nomenclature, phylogeny, *Senegalia*, *Vachellia*

Introduction

Molecular and other evidence has shown that the formerly broadly circumscribed, pantropical genus *Acacia* Mill. (Leguminosae: Mimosoideae) is polyphyletic and should be treated as comprising at least five genera, namely, *Acacia* Mill. sensu stricto, *Acaciella* Britton & Rose, *Mariosousa* Seigler & Ebinger, *Senegalia* Raf. and *Vachellia* Wight & Arn. (Miller & Seigler, 2012). Collectively, these five genera are called *Acacia* sensu lato in the discussion below. The name *Acacia* is now conserved with a new type (McNeill & Turland, 2011), an action which has had global nomenclatural repercussions. Although increasingly understood and adopted, the new classification for *Acacia* sensu lato has not yet been universally adopted, despite the fact that names congruent with the new classification are now available for most currently accepted taxa.

The indigenous species of *Acacia* sensu lato in East and Southeast Asia comprise 52 species, mostly belonging to *Senegalia* (see Appendix 1). These species are unevenly distributed across the region with centres of species-richness in Indonesia, Myanmar and Thailand (see Appendix 2). The term East Asia here refers to China and Taiwan where species of *Acacia* sensu lato occur both naturally and as introductions. The term

Southeast Asia includes the countries from Papua New Guinea through Indonesia, Philippines, Brunei, Vietnam, Laos, Cambodia (Kampuchea), Singapore, Malaysia, Thailand to Myanmar (Burma). Although New Guinea is geographically part of Australasia, it is included here for convenience and because the island is included in the largest Flora project in Southeast Asia, namely, *Flora Malesiana*. The species of *Acacia* sensu lato of this whole region are currently under review (Maslin, in prep.), a work that benefits greatly from the excellent taxonomic foundation provided by the late Ivan Nielsen for Southeast Asian taxa (Nielsen, 1980, 1981, 1985a, 1985b, 1992) and the treatments by Sun & Chen (1990) and Wu & Nielsen (2010) for taxa from China.

The aims of this communication are to summarise the rationale underlying the new classification and updated nomenclature of *Acacia* sensu lato and to show how this structure and these names apply to the indigenous species of East and Southeast Asia. This will provide an introduction to the above mentioned taxonomic review and will facilitate implementation of the new classification and nomenclature for the region.

Phylogeny and classification of *Acacia* sensu lato

As defined until relatively recently, the genus *Acacia* comprised a very large group of about 1350 species distributed throughout tropical and warm temperate areas of the world, occurring on all continents except Antarctica (web. ref. 1). However, during the past decade the genus has undergone fragmentation, a process that has been driven largely by evidence derived from molecular phylogenetic studies.

According to Bentham (1840), during the 80 years following its original description by Miller (1754) *Acacia* had become an "unwieldy, ill-defined, and comparatively unnatural assemblage of plants". Bentham (1842) remedied this situation by restricting the name *Acacia* (today's *Acacia* sensu lato) to Mimosoid plants having indefinite, free stamens, a definition that has persisted to modern times. In a series of subsequent publications, culminating in his 1875 *magnum opus*, Bentham did much to clarify not only the definition of *Acacia* but also its internal classification (Bentham, 1875). During the ensuing 60 years 15 new genera were described but these were ultimately treated as congeneric with *Acacia* sensu lato. A discussion of this generic history is outlined in Maslin et al. (web ref. 1).

In 1986 Pedley published a reassessment of the classification of *Acacia,* dividing the genus into three, namely, *Acacia* sensu stricto, *Senegalia* and *Racosperma* (DC.) Mart. These genera corresponded to three subgenera of *Acacia* sensu lato that had previously been recognised by Vassal (1972), namely, *Acacia* subgenera *Acacia*, *Aculeiferum* Vassal and *Heterophyllum* Vassal (=subgen. *Phyllodineae* (DC.) Seringe) respectively. At the time, Pedley's classification was not widely adopted for reasons that are outlined in Maslin (1989) and Maslin et al. (web ref. 1). One of these reasons was that the evidence presented was considered inconclusive and/or incomplete,

especially considering the significant impact to global nomenclatural that would flow from such a division.

However, since 1986 a number of broad-based, comparative studies (particularly using chloroplast and nuclear DNA) provided evidence that enabled more robust and informed decisions to be made concerning the phylogeny and classification of *Acacia* (see publications listed in Miller & Seigler, 2012). These studies included not only species of *Acacia* sensu lato and *Faidherbia* A.Chev. (which together comprise tribe Acacieae) but importantly, also included representatives from the related tribes Ingeae and Mimoseae. As summarised in Miller & Seigler (2012) this genetic data has consistently demonstrated that *Acacia* sensu lato is polyphyletic and comprises at least five monophyletic groups, which each warrant recognition as a distinct genus. These genera are shown in Table 1 and comprise (1) two small New World endemic genera, *Acaciella* (resurrected by Rico Arce & Bachman, 2006) and *Mariosousa* (new genus described in Seigler et al., 2006), (2) two relatively large pan-tropical genera, *Senegalia* (resurrected by Pedley, 1986) and *Vachellia* (which contains the original type species of *Acacia*, *A. nilotica* (L.) Willd. ex Del.), and (3) the enormous, predominantly Australian genus, *Acacia* sensu stricto (syn. *Racosperma*). *Vachellia* is taxonomically well-removed from the other genera of *Acacia* sensu lato, being nested within a paraphyletic tribe Mimoseae; as noted by Miller & Seigler (2012) there are two, well-supported subclades within *Vachellia*, one of African species and the other American, to which the type of *Vachellia*, *V. farnesiana* (L.) Wight & Arn., belongs. The other four genera are in a paraphyletic grade with genera of tribe Ingeae (fide Miller & Seigler, 2012). It is this five-genus classification for *Acacia* sensu lato that is generally accepted today. In addition to the phylogenetic evidence based on nucleotide data, a range of morphological, biochemical, palynological and other data help support, define and characterise the five genera (see Pedley, 1986; Chappill & Maslin, 1995; Maslin et al., 2003).

Notwithstanding the above it is possible that further generic segregates will be recognised within *Acacia* sensu lato, particularly as more taxa are added to the genetic datasets. Miller & Seigler (2012) have already suggested a possible new genus in South America, segregated from *Senegalia*, to accommodate species allied to *S. skleroxyla* (Tussac) Seigler & Ebinger. While major generic realignments are not anticipated for East and Southeast Asia (but see note below concerning *Delaportea* Gagnep.), it is noted that scarcely any species from the region has been included in existing comparative genetic studies of *Acacia* sensu lato

Nomenclature of *Acacia* sensu lato

In July 2011 the Nomenclature Section of the XVII International Botanical Congress (IBC) in Melbourne, Australia, voted with a clear majority (68%) to accept the *Vienna Code* (McNeill et al., 2007) that lists *Acacia* Mill. with a conserved type (McNeill & Turland, 2011). This action ended a long debate that began following the publication

of a formal proposal by Orchard & Maslin (2003) to replace the original type of *Acacia*, the African species *A. scorpioides* (L.) W.F.Wight (=*A. nilotica*), with a new type, the Australian species, *A. penninervis* Sieber ex DC. A major consequence of the Melbourne IBC decision is that the name *Acacia* now applies to the large, predominantly Australian group that was formerly called *Acacia* subgen. *Phyllodineae*; this group is referred to here as *Acacia sens. str.* and the name *Racosperma* is a synonym of it. Additionally, the name *Vachellia* is the correct name for the smaller, pan-tropical group that was formerly called *Acacia* subgen. *Acacia*. Further information concerning this nomenclatural issue is provided on the WorldWideWattle website (web ref. 2).

Combinations for almost all the currently recognised species of *Acacia* sensu lato now referable to *Acaciella*, *Mariosousa*, *Senegalia* and *Vachellia* have been made, with only 13 species (10 from Madagascar and three from Africa) outstanding (web ref. 3). The WorldWideWattle website (web ref. 4) provides a list of names under the new classification, and where appropriate, each name is cross-referenced to its analogue in *Acacia* when that group was treated as a single genus.

After the Vienna IBC, the 'new' generic names replacing *Acacia* sensu lato had begun to appear in a range of publications and web databases, and the trend continues today; however, there seems to have been a lesser uptake of these names by herbaria. As summarised by Maslin (2011), even prior to the Melbourne IBC the name *Vachellia* had been adopted, in lieu of *Acacia*, in many publications including Flora treatments, field guides, scientific research papers and books. One particularly important publication to adopt the new nomenclature early was *Mabberley's Plant-book* 3rd ed. (Mabberley, 2008), which is a primary reference source for the correct names of vascular plant genera and families of the world. The new nomenclature has now been adopted in some large web databases such as the National Center for Biotechnology Information (web ref. 5) and will be incorporated into the Catalogue of Life database and available online by mid 2015 (Y. Roskov, pers. comm.). Others web resources such as *Tropicos* (web ref. 6) and *The Plant List* (web ref. 7) currently adopt a half-way approach by listing many names as accepted under both *Acacia* and *Vachellia/Senegalia*. Some important legume-centric databases on the web still maintain the old nomenclature, e.g. the online version of *Legumes of the World* (web ref. 8) and the *International Legume Database & Information Service* (ILDIS) (web ref. 9). Furthermore, the online version of *Index Nominum Genericorum* (web ref. 10) still lists *A. scorpioides* as the type of *Acacia*. There are of course many possible reasons why the uptake of the new generic nomenclature has been slow, erratic or has not occurred at all. Resource and time limitations are two of the more obvious reasons, but some databases may simply not have the capacity to be changed (ILDIS is presently in this latter category).

In East and Southeast Asia the new names have begun to appear on the web with *Senegalia* being listed for both the Philippines (web ref. 11) and for the Hengduan Mountains region of south-central China (web ref. 12). Also, the new generic nomenclature has been adopted in the checklist of plants of China that is expected to be soon published and in the checklist of the plants of India that is currently in preparation and which is expected to appear online during 2015, and published in hard copy about a year thereafter. Australia has adopted the new nomenclature in its

national names database (web ref. 13) and Australian herbaria have by and large done likewise with their specimen records (web ref. 14). However, this was a relatively easy achievement for Australia because so few name and specimen records had to be changed, with just 11 indigenous species being affected (see Table 1).

It is recognised that it often takes a long time for taxonomic and nomenclatural changes to be accepted and implemented. For herbaria the adoption of such changes can be especially troublesome not only because of the large amount of work and resources needed to redetermine specimens and (often) modify database records, but also because of the disruption caused by having to re-arrange specimen storage systems. In the case of *Acacia* sensu lato these problems are compounded due to its very many species and global distribution (thus many herbaria are affected), and also because of the drawn-out debate over the application of the name *Acacia* itself. While some people may still wish that change had not occurred (a sentiment that is understandable) the fact remains that the international botanical nomenclatural community has voted in favour of *Acacia* retypification. It is therefore appropriate that the new nomenclature for *Acacia* sensu lato be adopted universally so that stability can be provided for this important group of legumes. There is now a particular imperative to achieve this nomenclatural stability because the global legume community is discussing ways to produce a new phylogenetic classification for the Leguminosae, one that will incorporate morphological data into the phylogeny (Bruneau et al., 2013). One of the basic starting points for this project will be the development of a core list of taxa; *Acacia* sensu lato, whose species constitute about a third of the total number for subfamily Mimosoideae, will be a significant component of that list.

The indigenous species of *Acacia* sensu lato in East and Southeast Asia

Current evidence shows *Acacia* sensu lato to be represented in the East and Southeast Asia by 52 native species accommodated in three genera, namely, *Acacia sens. str.*, *Senegalia* and *Vachellia*. The species are listed, together with their geographic distributions, in Appendices 1 and 2. However, it should be noted that some modification to these data can be expected to occur within the context of the review of *Acacia* sensu lato for East and Southeast that is currently in progress (Maslin, in prep.).

Acacia sensu stricto

Acacia sensu stricto (1073 species in total) is largely restricted to Australia where 1063 species occur (Table 1), making it the largest genus of vascular plants on that continent. Only 19 taxa (representing 18 species) occur naturally outside Australia (Brown et al., 2012), 12 in Asia and seven on islands of the Pacific.

All 12 Asian species are geographically restricted, one occurring in East Asia (*Acacia confusa* Merr. from Taiwan and the Philippines) and 11 in Southeast Asia. There are four endemic taxa, three in the south of the region, where *Acacia sp.* (Wetar)

and *A. wetarensis* Pedley are restricted to the small Indonesian island of Wetar and *A. peregrinalis* M.W.McDonald & Maslin which is confined to New Guinea, and one in the northeast (the above mentioned *A. confusa*). All eight species that extend beyond the region occur also in Australia. There are no indigenous species of *Acacia* sensu stricto in mainland China but a few are cultivated there (fide Wu & Nielsen, 2010).

The indigenous species of *Acacia* sensu stricto in East and Southeast Asia are shrubs or trees with phyllodinous foliage (bipinnate foliage occurs on a few introduced species in Asia). Like species of *Vachellia* they are generally found in drier habitats than those of *Senegalia*.

Some taxa of this genus form a significant component of the plantation forestry industry in parts of Southeast Asia, most notably in Indonesia and Vietnam, where *Acacia crassicarpa* A.Cunn. ex Benth., *A. mangium* Willd. and *A. auriculiformis* A.Cunn. ex Benth. × *mangium* are the main ones grown for pulp and solid wood products (see Griffin et al., 2011 for overview).

Senegalia

Senegalia (201 species in total) has a pantropical distribution and is represented by 45 species in Asia as a whole (19 in India), 68 in Africa, 102 in the Americas and 2 taxa in Australia (see Table 1).

There are 38 indigenous taxa of *Senegalia* (representing 32 species) in East and Southeast Asia, making it by far the largest group of *Acacia* sensu lato within the region. Thirteen taxa occur in East Asia with four, *Senegalia delevayi* (Franch.) Maslin et al. (var. *delavayi* and var. *kunmingensis* (C.Chen & H.Sun) Maslin et al.), *S. teniana* (Harms) Maslin et al. and *S. yunnanensis* (Franch.) Maslin et al., endemic in China. Thirty three taxa occur in Southeast Asia with almost half of them endemic to the sub-region, namely, *Senegalia borneensis* (I.C.Nielsen) Maslin et al., *S. comosa* (Gagnep.) Maslin et al., *S. donnaiensis* (Gagnep.) Maslin et al., *S. kekapur* (I.C.Nielsen) Maslin et al., *S. kostermansii* (I.C.Nielsen) Maslin et al., *S. meeboldii* (Craib) Maslin et al., *S. merrillii* (I.C.Nielsen) Maslin et al., *S. palawanensis* (I.C.Nielsen) Maslin et al., *S. pluricapitata* (Steud. ex Benth.) Maslin et al., *S. pluriglandulosa* (Verdc.) Maslin et al., *S. pseudointsia* (Miq.) Maslin et al., *S. sulitii* (I.C.Nielsen) Maslin et al., *S. tawitawiensis* (I.C.Nielsen) Maslin et al., *S. thailandica* (I.C.Nielsen) Maslin et al. and *S. verheijenii* (I.C.Nielsen) Maslin et al. These endemic taxa are scattered generally throughout the sub-region, occurring in all countries except Brunei (which has no indigenous *Acacia* sensu lato recorded). Indonesia has the highest concentration of sub-regional endemics with nine species recorded, but only *Senegalia kostermansii* and *S. verheijensii* are restricted to that country. Almost all of the 16 species of *Senegalia* that extend beyond the region range westward to India and nearby countries, with 10 also ranging north to China. Only one taxon, *Senegalia pennata* subsp. *kerrii* (I.C.Nielsen) Maslin et al., extends to Australia, which has a very poor representation of indigenous species of *Senegalia* (just two taxa, the endemic *S. albizioides* (Pedley) Pedley and *S. pennata* subsp. *kerrii*).

Species of *Senegalia* are characterised by having bipinnate leaves and cauline prickles. Most of the indigenous species of East and Southeast Asian are woody lianes with only the widespread *Senegalia catechu* (L.f.) P.J.H.Hurter & Mabb., *S. chundra* (Roxb. ex Rottler) Maslin and *S. ferruginea* (DC.) Pedley (all of which have prickles at the nodes) and the geographically restricted, endemic *S. kostermansii* from Indonesia and *S. teniana* from China (both of which have scattered prickles) seemingly obligate shrubs or trees which lack scandent branches. Most species have broad, flat, ±chartaceous and straight pods but in *Senegalia thailandica* the pods are slightly inflated and tightly curled. These species can be arranged in four sub-groups (defined principally by prickle distribution and leaflet characteristics) centred on *Senegalia pennata*, *S. caesia, S. andamanica* (I.C.Nielsen) Maslin et al. and *S. catechu* respectively. The one species with very different carpological features is the widespread and variable *Senegalia rugata* (Lam.) Britton & Rose (syn. *Acacia concinna* (Willd.) DC.). In this species the pods are smooth, thick and fleshy when fresh but they dry characteristically wrinkled, blackish and with a very hard texture. This species name has about 10 heterotypic synonyms and further study is needed to reassess the taxonomic status of *Senegalia rugata*. *Senegalia albizioides* (restricted to Australia) is currently the only recognised close relative of *S. rugata*.

Vachellia

Vachellia (163 species in total) has a pantropical distribution and is represented by 30 species in Asia as a whole (11 in India), 84 in Africa, 57 in the Americas and 8 in Australia (see Table 1).

There are just eight indigenous species of *Vachellia* in Southeast Asia (none occurs in East Asia), making it the least well-represented of the three genera within the region. There are five endemic species, all of which occur in northern areas, three restricted to Myanmar (*Vachellia inopinata* (Prain) Maslin et al., *V. kingii* (Prain) Maslin et al. and *V. myaingii* (Lace) Maslin et al.: all these species are poorly known and require study to reassess their taxonomic status), one to Thailand (*V. siamensis* (Craib) Maslin et al.) and one widespread (*V. harmandiana* (Pierre) Maslin et al. which occurs in Cambodia, Laos, Thailand, Vietnam). The three species that extend beyond the region, namely, *Vachellia nilotica* subsp. *indica* (Benth.) Kyal. & Boatwr., *V. leucophloea* (Roxb.) Maslin et al. and *V. tomentosa* (Rottler) Maslin et al., range westward to India with *V. nilotica* subsp. *indica* extending to the Middle East. Excluding *Vachellia harmandiana* and *V. leucophloea*, the only indigenous species of *Vachellia* that is widespread in Southeast Asia is *V. tomentosa*.

Gagnepain (1911, 1952) and Craib (1927) described species under new generic names, *Delaportea* and *Nimiria* Prain ex Craib respectively. At present these species are treated as conspecific with *Vachellia harmandiana, V. leucophloea* and *V. siamensis*. They appear to form a natural group that is recognised by an unusual combination of characters, namely, stipules spinescent (characteristic of *Vachellia*) and heads arranged in open, terminal panicles (characteristic of many species of *Senegalia*). Further field,

morphological and genetic study is needed to reassess the taxonomic status of this group and to determine if it is appropriate to resurrect the genus *Delaportea* (with *Nimiria* as a synonym).

Vachellia farnesiana (L.) Wight & Arn. has been recorded as an introduction (sometimes naturalised) in a number of countries of East and Southeast Asia (see Nielsen, 1981, 1985b, 1992; Wu & Nielsen, 2010). It is a native of tropical America and comprises three varieties (Seigler & Ebinger, 2005). Although it is not known what varieties occur in Asia it is most likely the typical one (D. Seigler, pers. comm.).

The indigenous species of *Vachellia* in Southeast Asia are shrubs or trees characterised by having bipinnate foliage subtended by spiny stipules. Like species of *Acacia sens. str.* they are generally found in drier sites than those of *Senegalia*.

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Appendix 1. Indigenous taxa of *Acacia* sensu lato currently recognised for East and Southeast Asia.
See Introduction for definition of the terms East and Southeast Asia. Only selected synonyms are given in this list.

ACACIA Mill., Gard. Dict. Abr., ed. 4, [25] (1754), *nom. cons.* TYPE: *Acacia penninervis* Sieber ex DC. (*typ. cons.*, vide Regnum Veg. 146: App. III, 286. 2006).

Racosperma (DC.) Mart., Hort. Reg. Monac. Semin. 4 (1835). LECTOTYPE: *Racosperma penninerve* (Sieber ex DC.) Pedley, Bot. J. Linn. Soc. 92: 239 (1986). Based on *Acacia* sect. *Phyllodineae* DC., Prodr. 2: 448 (1825).

Acacia auriculiformis A.Cunn. ex Benth., London J. Bot. 1: 377 (1842).
Distribution. **Southeast Asia:** Indonesia (Moluccas), Papua New Guinea. **Australia:** Northern Territory & Queensland.
Introduced/cultivated/naturalised. Americas (Florida, Panama), Africa, Bangladesh, Brunei, China, India (incl. Andaman Is.), Indonesia, Laos, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Vietnam.

Acacia confusa Merr., J. Sci. (Bot.) 5: 27 (1910).
Distribution. **East Asia:** Taiwan. **Southeast Asia:** Philippines.
Cultivated/introduced. China, Hawaiian Islands, India, Indonesia, Japan (southern Ryukyu Islands), Mauritius, Malaysia, Northern Marianas, Seychelles, Vietnam.

Acacia crassicarpa A.Cunn. ex Benth., London J. Bot. 1: 379 (1842).
Distribution. **Southeast Asia:** Papua New Guinea. **Australia:** Queensland.
Cultivated. Australia (Northern Territory), Vietnam.

Acacia leptocarpa A.Cunn. ex Benth., London J. Bot. 1: 376 (1842).
Distribution. **Southeast Asia:** Papua New Guinea. **Australia**: Northern Territory, Queensland, Western Australia.

Acacia mangium Willd., Sp. Pl., ed. 4, 4(2): 1053 (1806).
Distribution. **Southeast Asia:** Indonesia (New Guinea, Moluccas), Papua New Guinea. **Australia:** Queensland.
Introduced/naturalised. Americas (Nicaragua), Australia (Northern Territory), Bangladesh, Brunei, China, Central America (Nicaragua), India, Philippines, Singapore, Vietnam.

Acacia oraria F.Muell., Fragm. 11: 66 (1879).
Distribution. **Southeast Asia:** Indonesia (Flores, Timor). **Australia:** Queensland.

Acacia peregrinalis M.W.McDonald & Maslin, Nuytsia 14(3): 455 (2002).
Distribution. **Southeast Asia:** Indonesia (New Guinea), Papua New Guinea.

Acacia pubirhachis Pedley, Contr. Queensland Herb. 15: 15 (1974).
Distribution. **Southeast Asia:** Papua New Guinea. **Australia:** Queensland.

Acacia simsii A.Cunn. ex Benth., London J. Bot. 1: 368 (1842).
Distribution. **Southeast Asia:** Indonesia (New Guinea), Papua New Guinea. **Australia:** Northern Territory, Queensland.

Acacia spirorbis subsp. ***solandri*** (Benth.) Pedley, Austrobaileya 3: 216 (1990).
Distribution. **Southeast Asia:** Papua New Guinea. **Australia:** Queensland.

Acacia wetarensis Pedley, Contr. Queensland Herb. 18: 18 (1975).
Distribution. **Southeast Asia:** Indonesia (Wetar).

Acacia sp. **(Wetar)**.
Distribution. **Southeast Asia:** Indonesia (Wetar).
Note. This entity is noted by Nielsen (1992: 59) under *Acacia leptocarpa*. It appears close to the glabrous variant of *A. elachantha* M.W.McDonald & Maslin (McDonald & Maslin, 1997), and preliminary studies suggest that it may represent a distinct taxon.

SENEGALIA Raf., Sylva Tell. 119 (1838). LECTOTYPE: *Mimosa senegal* L. (*vide* Britton & Rose, N. Amer. Fl. 23: 106. 1928) (*Senegalia senegal* (L.) Britton [*Senegalia triacantha* Raf., *nom. illeg.*])

Senegalia andamanica (I.C.Nielsen) Maslin, Seigler & Ebinger, Blumea 58: 40 (2013). – *Acacia andamanica* I.C.Nielsen, *Adansonia* ser 2, 19: 354 (1980).
Distribution. **Southeast Asia:** Thailand. **South Asia:** Andaman Islands, Nicobar Islands.

Senegalia borneensis (I.C.Nielsen) Maslin, Seigler & Ebinger, Blumea 58: 40 (2013). – *Acacia borneensis* I.C.Nielsen, Opera Bot. 81: 20, fig. 9 (7–13) (1985).
Distribution. **Southeast Asia:** Indonesia (Kalimantan), Malaysia (Sabah).

Senegalia caesia (L.) Maslin, Seigler & Ebinger, Blumea 58: 40 (2013). – *Mimosa caesia* L., Sp. Pl. 1: 522 (1753). – *Acacia caesia* (L.) Willd., Sp. Pl., ed. 4, 4(2): 1090 (1806).
Distribution. **East Asia:** China (Guangdong, Hainan, Sichuan, Yunnan), Taiwan. **Southeast Asia:** Cambodia, Laos, Myanmar, Thailand, Vietnam. **South Asia:** Bangladesh, Bhutan, India, Sri Lanka.
Note. Although *Acacia caesia* var. *subnuda* (Craib) I.C.Nielsen is recognised by Nielsen (1981: 53) and Sanjappa (1992: 37), it is regarded as conspecific with *A. caesia* by Chakrabarty & Gangopadhyay (1996: 604) and Wu & Nielsen (2010: 57). Maslin et al. (2013) did not recognise the variety in *Senegalia*. Further study is required to reassess the taxonomic status of this variety.

Senegalia catechu (L.f.) P.J.H.Hurter & Mabb. in Mabberley's Plant-book ed. 3, 1021 (2008). – *Mimosa catechu* L.f., Suppl. Pl. 439 (1782 [1781 publ. Apr. 1782]). – *Acacia catechu* (L.f.) Willd., Sp. Pl., ed. 4, 4(2): 1079 (1806).
Distribution. **East Asia:** China (Yunnan). **Southeast Asia:** Myanmar, Thailand (uncertain, fide Lock & Heald 1994: 33). **South Asia:** Bangladesh, Bhutan, India, Nepal, Pakistan, Sri Lanka.
Cultivated/introduced. China (Fujian, Guangdong, Guangxi, Hainan, Yunnan, Zhejiang), Indonesia (Java), Japan (southern Ryukyu Islands), Mauritius, Philippines, Taiwan, Vietnam.

Senegalia chundra (Roxb. ex Rottler) Maslin, Nuytsia 22(6): 466 (2012). – *Mimosa chundra* Roxb. ex Rottler, Neue Schriften Ges. Naturf. Freunde Berlin 4: 207 (1803). – *Acacia chundra* (Roxb. ex Rottler) Willd., Sp. Pl. ed. 4, 4(2): 1078 (1806).
Acacia sundra (Roxb.) DC., Prodr. 2: 458 (1825). – *Mimosa sundra* Roxb., Pl. Corom. 3: 19, tab. 225 (1811).
Distribution. **Southeast Asia:** Myanmar. *South* Asia: India, Sri Lanka.
Introduced/naturalised. Australia: Northern Territory, Reunion Island.
Note. Despite their similar-sounding epithets, *Mimosa chundra* and *M. sundra* were independent descriptions based on different types, *fide* Maslin et al. (2013: 466). The complex nomenclatural history involving these names is discussed by Kshirsagar (web ref. 15).

Senegalia comosa (Gagnep.) Maslin, Seigler & Ebinger, Blumea 58: 40 (2013). – *Acacia comosa* Gagnep., Notul. Syst. (Paris) 2: 113 (1911).
Distribution. **Southeast Asia:** Cambodia, Laos, Thailand, Vietnam.

Senegalia delavayi (Franch.) Maslin, Seigler & Ebinger, Blumea 58: 40 (2013). – *Acacia delavayi* Franch., Pl. Delavay. 194 (1890).
Note. Two varieties recognised; both endemic to China.

Senegalia delavayi (Franch.) Maslin, Seigler & Ebinger var. **delavayi** – *Acacia delavayi* Franch. var. *delavayi* established by publication of *A. delavayi* var. *kunmingensis* C.Chen & H.Sun, Acta Bot. Yunnan. 12: 262 (1990).
Distribution. **East Asia:** China (Yunnan).

Senegalia delavayi var. ***kunmingensis*** (C.Chen & H.Sun) Maslin, Seigler & Ebinger, Blumea 58: 40 (2013). – *Acacia delavayi* var. *kunmingensis* C.Chen & H.Sun, Acta Bot. Yunnan. 12: 262 (1990).
Distribution. **East Asia:** China (Guizhou, Yunnan).

Senegalia donnaiensis (Gagnep.) Maslin, Seigler & Ebinger, Blumea 58: 40 (2013). – *Acacia donnaiensis* Gagnep., Not. Syst. (Paris) 2: 114 (1911).
Distribution. **Southeast Asia:** Cambodia, Indonesia (Kalimantan), Malaysia (Sabah), Vietnam.

Senegalia ferruginea (DC.) Pedley, Bot. J. Linn. Soc. 92: 250 (1986). – *Acacia ferruginea* DC., Prodr. 2: 458 (1825).
Distribution. **Southeast Asia:** Myanmar. **South Asia:** India, Sri Lanka.

Senegalia gageana (Craib) Maslin, Seigler & Ebinger, Blumea 58: 40 (2013). – *Acacia gageana* Craib, Bull. Misc. Inform. Kew 1915: 409 (1915).
Distribution. **Southeast Asia:** Myanmar. **South Asia:** Bangladesh, Bhutan, India, Nepal, Pakistan.

Senegalia intsia (L.) Maslin, Seigler & Ebinger, Blumea 58: 40 (2013). – *Mimosa intsia* L., Sp. Pl. 1: 522 (1753). – *Acacia intsia* (L.) Willd., Sp. Pl., ed. 4, 4(2): 1091 (1806).
Distribution. **Southeast Asia:** Myanmar. **South Asia:** Bangladesh, India, Nepal, Sri Lanka.

Senegalia kekapur (I.C.Nielsen) Maslin, Seigler & Ebinger, Blumea 58: 40 (2013). – *Acacia kekapur* I.C.Nielsen, Opera Bot. 81: 13, fig. 5 (1–8) (1985).
Distribution. **Southeast Asia:** Indonesia (Java, Sumatra), Singapore.
Note. Nielsen (1985a) noted that plants from NE Sumatra and Singapore may be taxonomically different from *S. kekapur sens. typ.* from Java and southern Sumatra; this matter is currently under investigation.

Senegalia kostermansii (I.C.Nielsen) Maslin, Seigler & Ebinger, Blumea 58: 40 (2013). – *Acacia kostermansii* I.C.Nielsen, Opera Bot. 81: 15 (1985).
Distribution. **Southeast Asia:** Indonesia (Alor Island, Sumbawa, Flores).

Senegalia meeboldii (Craib) Maslin, Seigler & Ebinger, Blumea 58: 40 (2013). – *Acacia meeboldii* Craib, Bull. Misc. Inform. 1928: 66 (1928).
Distribution. **Southeast Asia:** Myanmar, Thailand.

Senegalia megaladena (Desv.) Maslin, Seigler & Ebinger, Blumea 58: 41 (2013). – *Acacia megaladena* Desv., J. Bot. Agric. 3: 69 (1814).
Note. Three varieties recognised.

Senegalia megaladena (Desv.) Maslin, Seigler & Ebinger var. ***megaladena*** – *Acacia megaladena* Desv. var. *megaladena* established by publication of *A. megalodena* var. *garrettii* I.C. Nielsen and var. *indo-chinensis* I.C. Nielsen, Adansonia sér. 2, 19: 351 (1980).
Distribution. **East Asia:** China (Guangxi, Yunnan). **Southeast Asia:** Indonesia (Java), Laos, Myanmar, Thailand, Vietnam. **South Asia:** Bangladesh, India, Nepal.

Senegalia megaladena var. ***indochinensis*** (I.C.Nielsen) Maslin, Seigler & Ebinger, Blumea 58: 41 (2013). – *Acacia megaladena* var. *indochinensis* I.C.Nielsen, Adansonia sér. 2, 19: 351 (1980).
Distribution. **Southeast Asia:** Cambodia, Indonesia (Java, but probably introduced according to Nielsen 1985a: 26), Laos, ?Malaysia (recorded for northern Peninsular Malaysia by Nielsen 1985a: 26 & 1992: 51, but not listed in Turner 1997: 290), Thailand, Vietnam.

Senegalia megaladena var. ***garrettii*** (I.C.Nielsen) Maslin, Seigler & Ebinger, Blumea 58: 41 (2013). – *Acacia megaladena* var. *garrettii* I.C.Nielsen, Adansonia sér. 2, 19: 351 (1980).
Distribution. **East Asia:** China (Guangxi, Yunnan). **Southeast Asia:** Thailand.

Senegalia merrillii (I.C.Nielsen) Maslin, Seigler & Ebinger, Blumea 58: 41 (2013). – *Acacia merrillii* I.C.Nielsen, Opera Bot. 81: 9, fig. 2 (1985).
Distribution. **Southeast Asia:** Indonesia (Moluccas, Sulawesi), Philippines.

Senegalia palawanensis (I.C.Nielsen) Maslin, Seigler & Ebinger, Blumea 58: 41 (2013). – *Acacia palawanensis* I.C.Nielsen, Opera Bot. 81: 16, fig. 6 (7–11) (1985).
Distribution. **Southeast Asia:** Philippines.

Senegalia pennata (L.) Maslin, Nuytsia 22(6): 466 (2012). – *Mimosa pennata* L., *Sp. Pl.* 1: 522 (1753). – *Acacia pennata* (L.) Willd., Sp. Pl., ed. 4, 4(2): 1090 (1806).
Note. Four subspecies recognised.

Senegalia pennata subsp. ***pennata***. – *Acacia pennata* (L.) Willd. subsp. *pennata* established by publication of *A. pennata* subspp. *hainanensis* (Hayata) I.C. Nielsen, *insuavis* (Lace) I.C.Nielsen and *kerri* I.C.Nielsen, Adansonia ser. 2, 19(3): 352–353 (1980).
Distribution. **Southeast Asia:** Myanmar, Thailand (probably introduced). **South Asia:** Bangladesh, Bhutan, India, Nepal, Sri Lanka.

Senegalia pennata subsp. ***hainanensis*** (Hayata) Maslin, Seigler & Ebinger, Blumea 58: 41 (2013). – *Acacia hainanensis* Hayata, Ic. Pl. Formos. 3: 86 (1913). – *Acacia pennata* subsp. *hainaneusis* (Hayata) I.C. Nielsen, Adansonia sér. 2, 19(3): 352 (1980).
Distribution. **East Asia:** China (Fujian, Guangdong, Guangxi, Hainan, Yunnan). **Southeast Asia:** Myanmar, Vietnam. **South Asia:** India.

Senegalia pennata subsp. ***insuavis*** (Lace) Maslin, Seigler & Ebinger, Blumea 58: 41 (2013). – *Acacia insuavis* Lace, Bull. Misc. Inform. 1915: 401 (1915). – *Acacia pennata* subsp. *insuavis* (Lace) I.C.Nielsen, Adansonia ser. 2, 19(3): 353 (1980).
Distribution. **Southeast Asia:** Cambodia, Laos, Myanmar. **South Asia:** India.
Introduced/cultivated. USA (Florida), Australia (Northern Territory, Queensland), Singapore, Thailand.
Note. Pedley (2014) treated this entity as *S. insuavis* (Lace) Pedley; however, its taxonomic status is currently under investigation by the present author.

Senegalia pennata subsp. ***kerrii*** (I.C.Nielsen) Maslin, Nuytsia 22(6): 467 (2012).
Acacia pennata subsp. *kerrii* I.C.Nielsen, Adansonia ser. 2, 19(3): 353 (1980).
Distribution. **Australia:** Queensland. **East Asia:** China (Yunnan). **Southeast Asia:** Cambodia, East Timor, Indonesia (Java, Sulawesi, Flores, Komodo, Lombok, Sumbawa), Laos, Malaysia (Peninsular Malaysia), Myanmar, Thailand, Vietnam. **South Asia:** Bhutan, India, Nepal, Sri Lanka.

Senegalia pluricapitata (Steud. ex Benth.) Maslin, Seigler & Ebinger, Blumea 58: 41 (2013).
Acacia pluricapitata Steud. ex Benth., London. J. Bot. 1: 516 (1842).
Distribution. **Southeast Asia:** Indonesia (Sumatra, Java, Kalimantan), Malaysia (Peninsular Malaysia, Sabah), ?Myanmar, Philippines, Thailand, Vietnam.

Senegalia pluriglandulosa (Verdc.) Maslin, Seigler & Ebinger, Blumea 58: 41 (2013). – *Acacia pluriglandulosa* Verdc., Kew Bull. 32: 472 (1978).
Distribution. **Southeast Asia:** Indonesia (West Papua), Papua New Guinea, Philippines.

Senegalia pruinescens (Kurz) Maslin, Seigler & Ebinger, Blumea 58: 41 (2013). – *Acacia pruinescens* Kurz, J. Asiat. Soc Bengal, Pt. 2, Nat. Hist. 45: 296, 298 (1877).
Distribution. **East Asia:** China (Guangxi, Yunnan). **Southeast Asia:** Myanmar, Vietnam. **South Asia:** India.

Senegalia pseudointsia (Miq.) Maslin, Seigler & Ebinger, Blumea 58: 41 (2013). – *Acacia pseudointsia* Miq., Fl. Ned. Ind. 1: 12 (1855), as '*Pseudo-Intsia*.
Distribution. **Southeast Asia:** Indonesia (Java, Sumatra), Malaysia (Peninsular Malaysia, Sabah, Sarawak), Thailand.

Senegalia rugata (Lam.) Britton & Rose, N. Amer. Fl. 23(2): 120 (1928). – *Mimosa rugata* Lam., Encycl. 1: 20 (1783).
Acacia concinna (Willd.) DC., Prodr. 2: 464 (1825). – *Mimosa concinna* Willd., Sp. Pl., ed. 4, 4(2): 1039 (1806).
Distribution. **East Asia:** China (Fujian, Guangdong, Guangxi, Guizhou, Hainan, Hunan, Jiangxi, Yunnan). **Southeast Asia:** Cambodia, Indonesia (Ambon, Java, Kai Is., Sumba, Flores, Moluccas, Sulawesi, Sumatra), Laos, Malaysia (Peninsular Malaysia), Myanmar, Papua New Guinea, Philippines, Thailand, Vietnam. **South Asia:** Bangladesh, Bhutan, India (incl. Andaman Is.), Nepal.
Introduced. Australia (Queensland), Japan (Okinawa), Madagascar, Mauritius, Reunion Island.
Note. A variable species in need of critical revision.

Senegalia sulitii (I.C.Nielsen) Maslin, Seigler & Ebinger, Blumea 58: 42 (2013). – *Acacia sulitii* I.C.Nielsen, Opera Bot. 81: 24, fig. 10 (6–10) (1985).
Distribution. **Southeast Asia:** Indonesia (Sulawesi), Philippines.

Senegalia tawitawiensis (I.C.Nielsen) Maslin, Seigler & Ebinger, Blumea 58: 42 (2013). – *Acacia tawitawiensis* I.C.Nielsen, Opera Bot. 81: 22, fig. 10 (1–5) (1985).
Distribution. **Southeast Asia:** Philippines.

Senegalia teniana (Harms) Maslin, Seigler & Ebinger, Blumea 58: 42 (2013). – *Acacia teniana* Harms, Repert. Spec. Nov. Regni Veg. 17: 133 (1921).
Distribution. **East Asia:** China (Yunnan, Sichuan).

Senegalia thailandica (I.C.Nielsen) Maslin, Seigler & Ebinger, Blumea 58: 42 (2013). – *Acacia thailandica* I.C.Nielsen, Adansonia sér. 2, 19: 356, pl. 1 (1980).
Distribution. **Southeast Asia:** Cambodia, Thailand.

Senegalia tonkinensis (I.C.Nielsen) Maslin, Seigler & Ebinger, Blumea 58: 42 (2013). – *Acacia tonkinensis* I.C.Nielsen, Adansonia sér. 2, 19: 358, pl. 2 (1980).
Distribution. **East Asia:** China (Yunnan). **Southeast Asia:** Laos, Thailand, Vietnam.

Senegalia torta (Roxb.) Maslin, Seigler & Ebinger, Blumea 58: 42 (2013). – *Mimosa torta* Roxb., Fl. Ind., ed. 2, 2: 566 (1832). – *Acacia torta* (Roxb.) Craib, Kew Bull. 1915: 410 (1915).
Distribution. **Southeast Asia**: ?Thailand. **South Asia:** India, Pakistan.
Note. It is unlikely that this species occurs in Southeast Asia. The Thailand records by Nielsen (1985b: 167) are probably *Senegalia tonkinensis* (fide Srisanga & Sasirat, 2000).

Senegalia verheijenii (I.C.Nielsen) Maslin, Seigler & Ebinger, Blumea 58: 42 (2013). – *Acacia verheijenii* I.C.Nielsen, Opera Bot. 81: 16, fig. 6 (1–6) (1985).
Distribution. **Southeast Asia:** Indonesia (Flores).

Senegalia vietnamensis (I.C.Nielsen) Maslin, Seigler & Ebinger, Blumea 58: 42 (2013). – *Acacia vietnamensis* I.C.Nielsen, Adansonia sér. 2, 19: 360, pl. 3 (1980).
Distribution. **Southeast Asia:** Laos, Vietnam. (Erroneously recorded for China by Wu & Nielsen 2010: 57).

Senegalia yunnanensis (Franch.) Maslin, Seigler & Ebinger, Blumea 58: 42 (2013). – *Acacia yunnanensis* Franch., Pl. Delavay. 193 (1890).
Distribution. **East Asia:** China (Yunnan, Sichuan).

VACHELLIA Wight & Arn., *Prodr*. 272 (1834). TYPE: *Vachellia farnesiana* (L.) Wight & Arn.

Delaportea Thorel ex Gagnep., Notul. Syst. (Paris) 2: 117 (1911). TYPE: *Delaportea armata* Thorel ex Gagnep. (= *Vachellia harmandiana* (Pierre) Maslin, Seigler & Ebinger).

Nimiria Prain ex Craib, Bull. Misc. Inform. 1927: 393 (1927). TYPE: *Nimiria siamensis* Craib (= *Vachellia siamensis* (Craib) Maslin, Seigler & Ebinger).

Vachellia harmandiana (Pierre) Maslin, Seigler & Ebinger, Blumea 58: 42 (2013). – *Pithecolobium harmandianum* Pierre, Fl. Forest. Cochinch. 5: tab. 394A (1899). – *Acacia harmandiana* (Pierre) Gagnep., Not. Syst. (Paris) 2: 115 (1911). – *Delaportea armata* Thorel ex Gagnep., Not. Syst. (Paris) 2: 118 (1911).
Distribution. **Southeast Asia:** Cambodia, Laos, Thailand, Vietnam.

Vachellia inopinata (Prain) Maslin, Seigler & Ebinger, *Blumea* 58: 42 (2013). – *Acacia inopinata* Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 66: 507 (1897). – *Nimaria inopinata* (Prain) Craib, Bull. Misc. Inform. Kew 1927: 393 (1927).
Distribution. **Southeast Asia:** Myanmar.

Vachellia kingii (Prain) Maslin, Seigler & Ebinger, Blumea 58: 42 (2013). – *Acacia kingii* Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 66: 506 (1897).
Distribution. **Southeast Asia:** Myanmar.

Vachellia leucophloea (Roxb.) Maslin, Seigler & Ebinger, Blumea 58: 42 (2013). – *Mimosa leucophloea* Roxb., Pl. Coromandel 2: 27, tab. 150 (1800). – *Acacia leucophloea* (Roxb.) Willd., Sp. Pl., ed. 4, 4(2): 1083 (1806).
Delaportea microphylla Gagnep., Bull. Soc. Bot. Fr. 99: 46 (1952).
Delaportea ferox Gagnep., Bull. Soc. Bot. Fr. 99: 47 (1952).

Distribution. **Southeast Asia:** East Timor, Indonesia (Java, Bali, Timor), Laos, Malaysia (Peninsular Malaysia), Myanmar, Thailand, Vietnam. **South Asia:** India, Pakistan, Sri Lanka. *Introduced*. Mauritius, Trinidad.
Note. Maslin et al. (2013: 42–43) recognise two varieties, *Vachellia leucophloea* var. *leucophloea* and var. *microcephala* (Kurz) Maslin, Seigler & Ebinger (recorded only for Myanmar). The taxonomic status of *Vachellia leucophloea* var. *microcephala*, however, needs to be reviewed.

Vachellia myaingii (Lace) Maslin, Seigler & Ebinger, Blumea 58: 43 (2013). – *Acacia myaingii* Lace, Bull. Misc. Inform. 1915: 114 (1915), as "Myaingii".
Distribution. **Southeast Asia:** Myanmar.

Vachellia nilotica (L.) P.J.H. Hurter & Mabb. subsp. ***indica*** (Benth.) Kyal. & Boatwr., Bot. J. Linn. Soc. 172: 515 (2013). – *Acacia arabica* var. *indica* Benth., London J. Bot. 1: 500 (1842). – *Acacia nilotica* subsp. *indica* (Benth.) Brenan, Kew Bull. 12: 84 (1957).
Distribution. **Southeast Asia:** Myanmar. **South Asia:** Bangladesh, India, Nepal, Pakistan. **West Asia:** Iran, North Yemen, Oman, Qatar, South Yemen.
Introduced/naturalised. Africa, America, Australia (Northern Territory, Queensland, South Australia, Western Australia), India (Andaman Is.), Indonesia (Timor), Sri Lanka.

Vachellia siamensis (Craib) Maslin, Seigler & Ebinger, Blumea 58: 43 (2013). – *Nimiria siamensis* Craib, Bull. Misc. Inform. 1927: 393 (1927). – *Acacia craibii* I.C.Nielsen, Adansonia ser.2, 19(3): 344 (1980).
Distribution. **Southeast Asia:** Thailand.

Vachellia tomentosa (Rottler) Maslin, Seigler & Ebinger, Blumea 58: 43 (2013). – *Mimosa tomentosa* Rottler, Ges. Naturf. Freunde Berlin Neue Schriften 4: 208 (1803). – *Acacia tomentosa* Willd. Sp. Pl., ed. 4, 4(2): 1087 (1806).
Distribution. **Southeast Asia:** East Timor, Indonesia (Java, Sumba, Sumbawa, Sulawesi), Myanmar, Thailand, Vietnam. **South Asia:** Bangladesh, India, Sri Lanka.

Appendix 2. Indigenous taxa of *Acacia* sensu lato in East and Southeast Asia, listed by country of occurrence.
See Introduction for definition of the terms East and Southeast Asia. E = endemic (additional to the 15 country-specific endemics shown below there are 10 species of *Senegalia* that are endemic to Southeast Asia which occur in more than one country, see text above).

East Asia		
China	10 species (13 taxa)	*Senegalia caesia*, *S. catechu*, *S. delavayi* (var. *delavayi* & var. *kunmingensis*) [both E], *S. megaladena* (var. *megaladena* & var. *garrettii*), *S. pennata* (subsp. *hainanensis* & subsp. *kerrii*), *S. pruinescens*, *S. rugata*, *S. teniana* [E], *S. tonkinensis*, *S. yunnanensis* [E].
Taiwan	2 species	*Acacia confusa*. *Senegalia caesia*.
Southeast Asia		
Brunei	0	No indigenous species recorded.

Cambodia	8 species (9 taxa)	*Senegalia caesia*, *S. comosa*, *S. donnaiensis*, *S. megaladena* var. *indochinensis*, *S. pennata* (subsp. *insuavis*. & subsp. *kerrii*), *S. rugata*, *S. thailandica*. *Vachellia harmandiana*.
East Timor	3 species	*Senegalia pennata* subsp. *kerrii*. *Vachellia leucophloea*, *V. tomentosa*.
Indonesia	21 species (22 taxa)	*Acacia auriculiformis*, *A. mangium*, *A. oraria*, *A. peregrinalis*, *A. wetarensis* [E], *A. sp.* (Wetar) [E]. *Senegalia borneensis*, *S. donnaiensis*, *S. kekapur*, *S. kostermansii* [E], *S. megaladena* (var. *megaladena* & var. *indochinensis* – probably introduced, see note above), *S. merrillii*, *S. pennata* subsp. *kerrii*, *S. pluricapitata*, *S. pluriglandulosa*, *S. pseudointsia*, *S. rugata*, *S. sulitii*, *S. verheijensii* [E]. *Vachellia leucophloea*, *V. tomentosa*.
Laos	9 species (11 taxa)	*Senegalia caesia*, *S. comosa*, *S. megaladena* (var. *indochinensis* & var. *megaladena*), *S. pennata* (subsp. *insuavis*. & subsp. *kerrii*), *S. rugata*, *S. tonkinensis*, *S. vietnamensis*. *Vachellia harmandiana*, *V. leucophloea*.
Malaysia	8 species	*Senegalia borneensis*, *S. donnaiensis*, *S. megaladena* var. *indochinensis* (uncertain, see note above), *S. pennata* subsp. *kerrii*, *S. pluricapitata*, *S. pseudointsia*, *S. rugata*. *Vachellia leucophloea*.
Myanmar	18 species (21 taxa)	*Senegalia caesia*, *S. catechu*, *S. chundra*, *S. ferruginea*, *S. gageana*, *S. intsia*, *S. meeboldii*, *S. megaladena* var. *megaladena*, *S. pennata* (subsp. *hainanensis*, subsp. *insuavis*, subsp. *kerrii* & subsp. *pennata*), *S. pluricapitata* (uncertain), *S. pruinescens*, *S. rugata*. *Vachellia inopinata* [E], *V. kingii* [E], *V. leucophloea*, *V. myaingii* [E], *V. nilotica* subsp. *indica*, *V. tomentosa*.
Papua New Guinea	10 species	*Acacia auriculiformis*, *A. crassicarpa*, *A. leptocarpa*, *Acacia mangium*, *A. peregrinalis*, *A. pubirhachis*, *A. simsii*, *A. spirorbis* subsp. *solandri*. *Senegalia pluriglandulosa*, *S. rugata*.
Philippines	8 species	*Acacia confusa*. *Senegalia merrillii*, *S. palawanensis* [E], *S. pluricapitata*, *S. pluriglandulosa*, *S. rugata*, *S. sulitii* [E], *S. tawitawiensis* [E].
Singapore	1 species	*Senegalia kekapur*.
Thailand	17 species (20 taxa)	*Senegalia andamanica*, *S. caesia*, *S. catechu* (uncertain), *S. comosa*, *S. meeboldii*, *S. megaladena* (var. *indochinensis*, var. *megaladena* & var. *garrettii*), *S. pennata* (subsp. *kerrii* & subsp. *pennata*), *S. pluricapitata*, *S. pseudointsia*, *S. rugata*, *S. thailandica*, *S. tonkinensis*, *S. torta* (unlikely, see note above). *Vachellia harmandiana*, *V. leucophloea*, *V. siamensis* [E], *V. tomentosa*.
Vietnam	13 species (15 taxa)	*Senegalia caesia*, *S. comosa*, *S. donnaiensis*, *S. megaladena* (var. *indochinensis*, var. *megaladena*), *S. pennata* (subsp. *hainanensis* and subsp. *kerrii*), *S. pluricapitata*, *S. pruinescens*, *S. rugata*, *S. tonkinensis*, *S. vietnamensis*. *Vachellia harmandiana*, *V. leucophloea*, *V. tomentosa*.

Table 1. Classification schemes for *Acacia* sensu lato showing species numbers and major areas of occurrence.
Column 3 (in **bold**) gives the current classification and nomenclature of *Acacia* sensu lato. Species numbers are sourced from the WorldWideWattle website (web ref. 4) plus 19 Australian species of *Acacia* sensu stricto published in recent years but not yet posted to that site (see Maslin, 2014a–d; Maslin & Barrett, 2014; Kodela, 2015); these numbers refer to accepted, indigenous species only (not including infraspecific, informal or hybrid formulae taxa).

Pre-Vienna IBC names (*Acacia* treated as a single genus with *A. nilotica* the type)	Post-Vienna IBC names; *Acacia* sensu lato treated as five genera						
	With *Acacia nilotica* the type	**With *Acacia penninervis* the type**	**Species numbers and distribution**				
			Americas	Africa[1]	Asia[2]	Australia /Pacific	Total
Acacia subgenus *Acacia*	*Acacia*	***Vachellia***	**57**	**84[3]**	**30**	**9**	**163[3]**
subgenus *Aculeiferum*							
section *Spiciflorae*	*Senegalia*	***Senegalia***	**102**	**68[4]**	**45**	**2**	**201[4]**
section *Filicinae*	*Acaciella*	***Acaciella***	**15**	**0**	**0**	**0**	**15**
Acacia coulteri group	*Mariosousa*	***Mariosousa***	**13**	**0**	**0**	**0**	**13**
subgenus *Phyllodineae*	*Racosperma*	***Acacia***	**0**	**0[5]**	**13**	**1064[6]**	**1067**

[1]Including Madagascar and Mascarenes. [2]New Guinea to the Middle East. [3]Including three species in Madagascar and one in Africa for which combinations are not yet available in *Vachellia*. [4]Including seven species in Madagascar and two in Africa for which combinations are not yet available in *Senegalia*. [5]*Acacia heterophylla* was formerly recognised for Reunion Island but was recently shown by Le Roux et al. (2014) to be conspecific with the Hawaiian species *A. koa* and to have colonised the Mascarene archipelago directly from the Hawaiian Islands ≤ 1.4 million yr ago. [6]1057 species in Australia, seven in the Pacific region.

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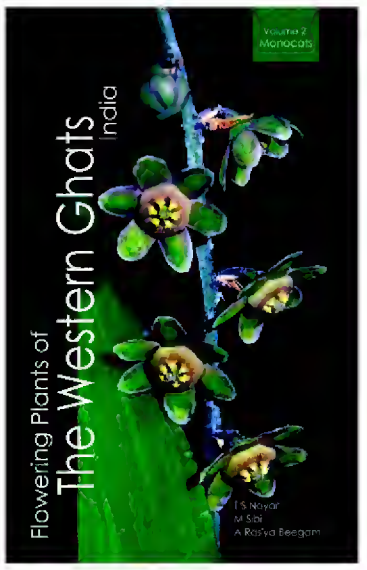
BOOK REVIEW: **Flowering Plants of the Western Ghats, Volume 1 (Dicots)** ***T.S. Nayar, A. Rasiya Beegam & M. Sibi***. 2014 & **Flowering Plants of the Western Ghats, Volume 2 (Monocots).** ***T.S. Nayar, M. Sibi & A. Rasiya Beegam***. 2014.

Thiruvananthapuram: Jawaharlal Nehru Tropical Botanic Garden and Research Institute. 26 × 16.5 cm, hard cover, 1683 pp (Vols. 1. & 2). ISBN 978-81-920098-2-7 (Vol. 1) & ISBN 978-81-920098-3-4 (Vol. 2). Price for the set of two volumes INR 3500 / US$ 200.



The mountain range of the Western Ghats, which extends along the western coast of the Indian subcontinent and exceeds 1600 km in length, is a well-known biodiversity hotspot and a UNESCO World Heritage Site. It is home to more than 8000 taxa of flowering plants, of which about 15% are endemic to the area. The Western Ghats run through six states (from north to south: Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu) and although there are published checklists and/or Floras for each of these states, there has not hitherto been a work focusing on the entire range. As such, this large and comprehensive checklist of Flowering Plants is a very welcome addition to the literature on Indian plants.

The checklist is published in two volumes. Volume 1 starts with a short introduction to the Western Ghats, including basic information on the geography of the region, rainfall, climate, major rivers, and forest types, together with a schematic map. In the paragraph on methodology, the authors describe how they acquired and verified the information. The main body of Volume 1 is dedicated to an account of Dicot families (arranged alphabetically) and genera (also arranged alphabetically, but with cultivated taxa placed at the end of each family). Volume 2 deals with Monocots in the same manner, but also includes two Addenda: additional taxa to be included while the work was in production, and a list of species of doubtful occurrence. There is also a list of references, and indices to scientific and local names. The index of local names consists of over 13,000 entries and covers six languages spoken across the area: Gujarati, Hindi, Kannada, Malayalam, Marathi and Tamil. The entire work is almost 1700 pages long.

The checklist is well-formatted, making full use of various fonts to provide additional information (e.g. when the Western Ghats are highlighted in bold, it means it is endemic to the area; and when the reference number is in italics it means that the plant name is treated there as a synonym). The User's Key explains well how the entries are constructed and referenced, as well as explaining the formatting details, making the work easy to use.

Each taxon entry starts with its accepted name, followed by any synonyms, its habit and the availability of a description and illustration of the taxon. Information on

its complete native distribution is followed by its distribution and phenology within the Western Ghats. These are followed by the threat category, economic importance and a list of local names. Considering that this is just a checklist, it is surprisingly well referenced. The list of references contains full citations to 2936 numbered works with these numbers referenced in each entry to justify the information provided and to allow the reader to follow up on details if needed.

A random check on families with which I am familiar shows that the authors have strived to gather the latest literature to ensure that the names used are indeed, in the vast majority of cases, up-to-date. However, I did spot some unusual placements of genera, e.g. *Cheilocostus* and *Costus* of the family Costacaeae are placed in the Zingiberaceae. The family Costaceae has been unambiguously recognised for at least the last 50 years and has been reflected in all major recent works and databases, including those used by the authors for verifications, so their family concept comes as a bit of a surprise.

As a potential end user I regret that such a work as this, during an era of rapid botanical exploration and publication, will inevitably become outdated in a few years, and was not rather designed as an online project. Not only would that have allowed various targeted searches to be performed, but the authors could also more dynamically keep the data updated and respond to feedback. It may also perhaps have formed the kernel of an expansion of the project into fully-fledged Flora of the Western Ghats, which could also be illustrated. It would be lovely to see ferns and gymnosperms also included.

Considering the extent of this work, the authors must no doubt be congratulated on the final product, which must have required much perseverance and the ability to cope with extremely large numbers of names, synonyms and references.

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