

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

J. Leong-Škorničková¹ & P.C. Boyce²

¹Herbarium, Singapore Botanic Gardens, National Parks Board,
1 Cluny Road, 259569, Singapore
jana_skornickova@nparks.gov.sg

²Institute of Biodiversity and Environmental Conservation (IBEC),
Universiti Malaysia Sarawak, 94300 Samarahan, Sarawak, Malaysia
phymatarum@gmail.com

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 Nurfaizilah 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 Nurfaizilah 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 Nurfaizilah 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 Nurfaizilah 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 or 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 Nurfaizilah et al. (2011), descriptions of seeds were unfortunately not provided by Siti Nurfaizilah 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

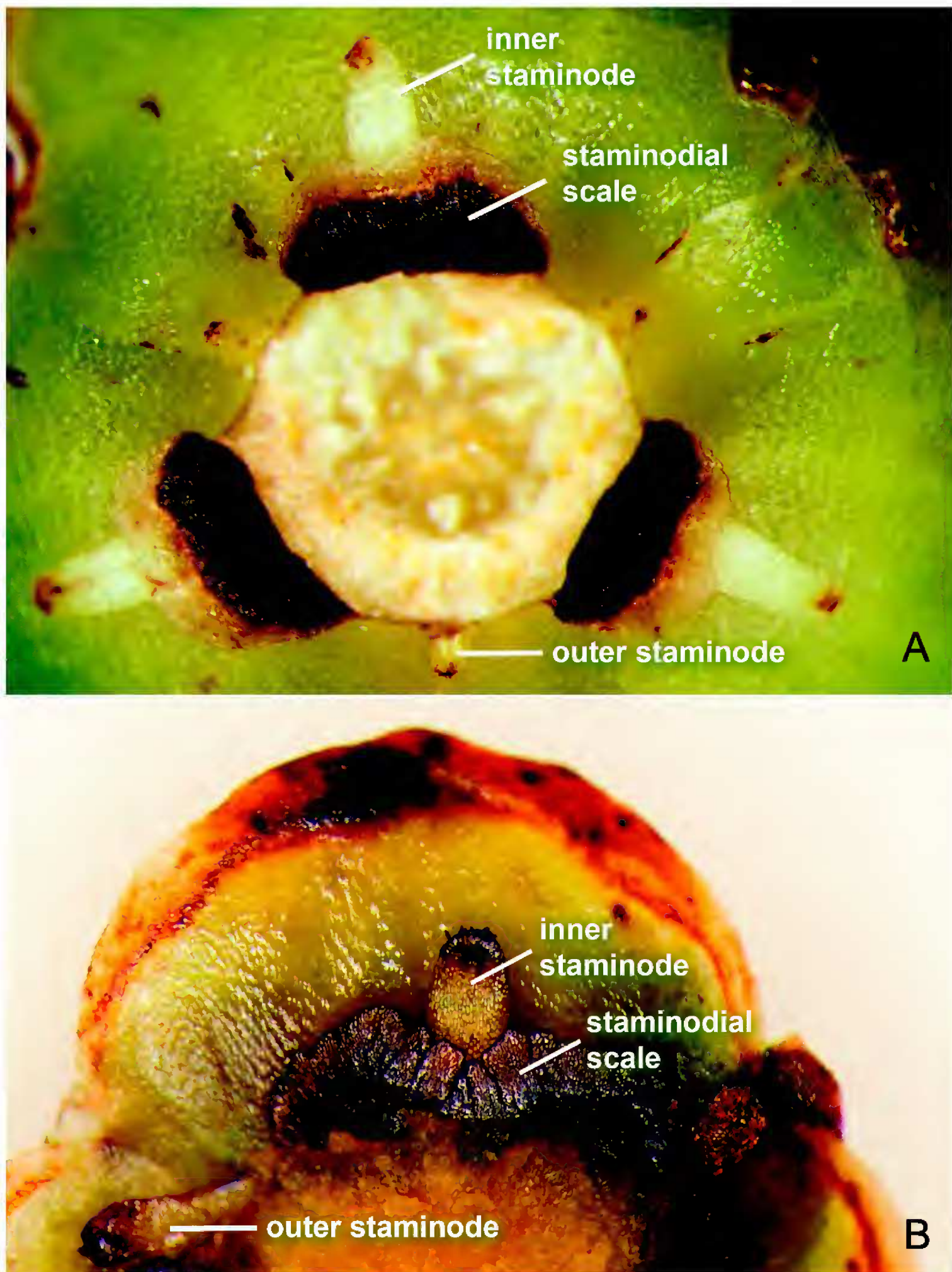


Fig. 1. Detail of staminodial scales at the base of inner staminodes. **A.** *Hanguana triangulata* Škorničk. & P.C.Boyce. Note the presence of a hyaline margin on the staminodial scale. **B.** *Hanguana malayana* (Jack.) Merr. Note the staminodial scale has no hyaline margin and is composed of lobes. (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 Nurfaizilah 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 $\frac{3}{4}$ 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.** Inflorescence with fruits in various stages of ripeness (immature green to glossy black mature fruits). From type *JLS-2793*. (Photos: Jana Leong-Škorníčková)

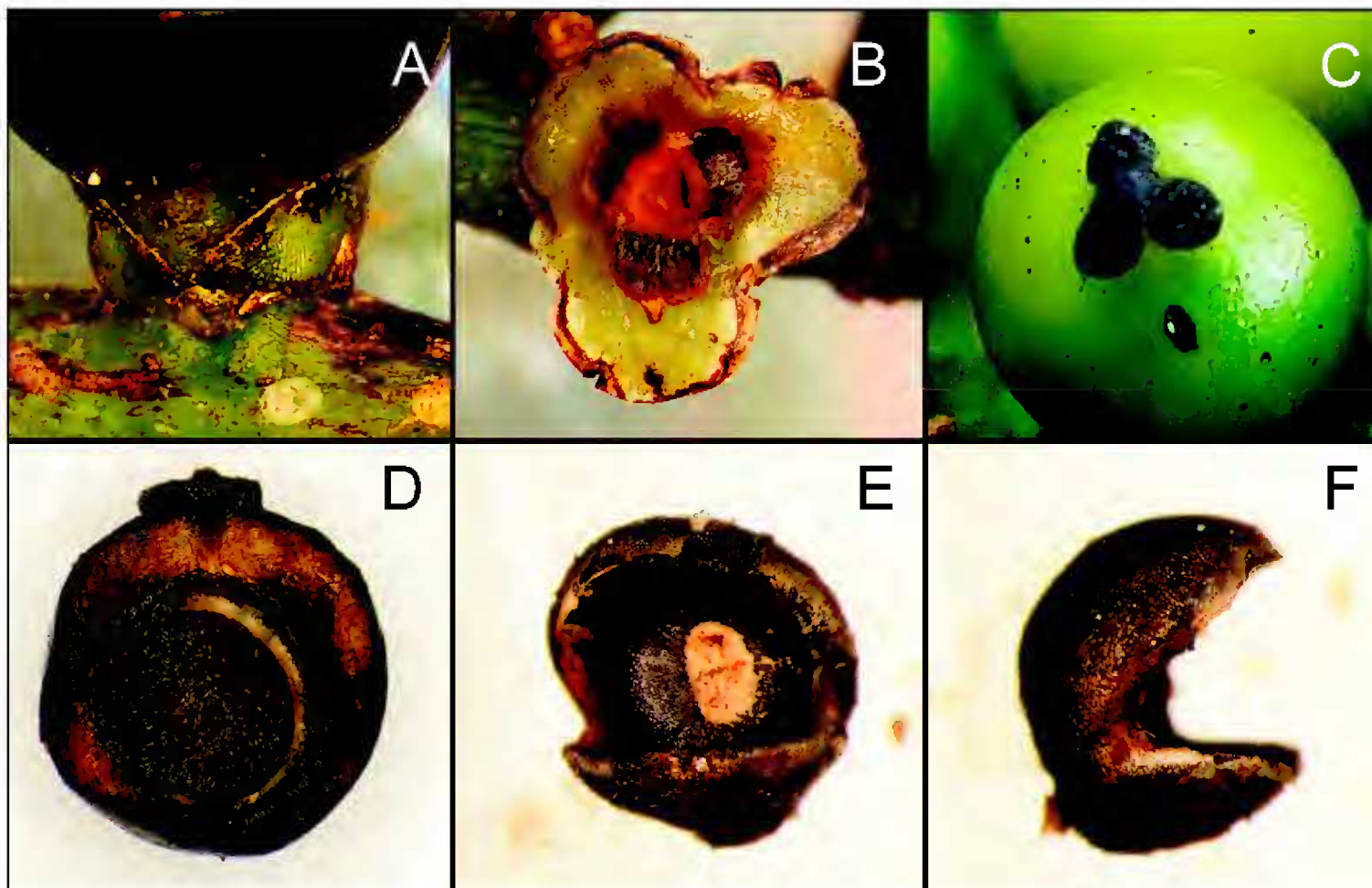


Fig. 3. *Hanguana neglecta* Škorničk. & Niissalo. **A.** Detail of tepals (side view). **B.** Detail of inner tepals, staminodes and staminodial scales. **C.** Detail of stigma on young fruit. **D.** Longitudinal section of fruit, which is always single-seeded. **E.** Seed (top view). **F.** Seed (side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

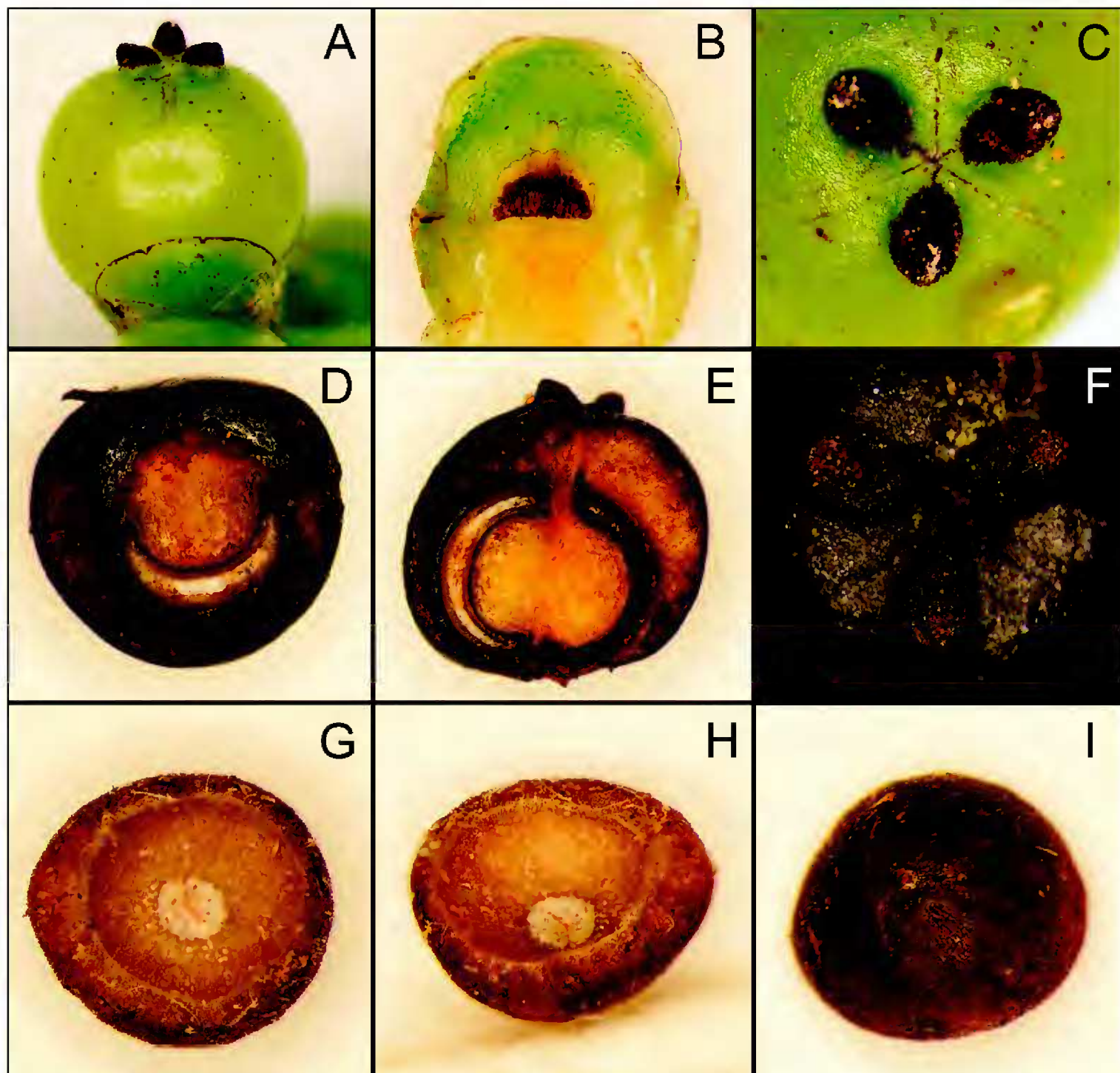


Fig. 5. *Hanguana nitens* Siti Nurfaizilah, Mohd Fahmi, Sofiman Othman & P.C.Boyce. **A.** Detail of tepals (side view). **B.** Detail of inner tepal, staminode and staminodial scale. **C.** Detail of stigma on young fruit. **D.** Cross section of fruit showing single seed and two empty locules. **E.** 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 km², 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 m² 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 Lumpur, 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 Nurfaizilah 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 Nurfaizilah 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 Nurfaizilah 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 appressed 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. 3/4 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.** Inflorescence. From type *JLS-3037*. (Photos: Jana Leong-Škorničková)

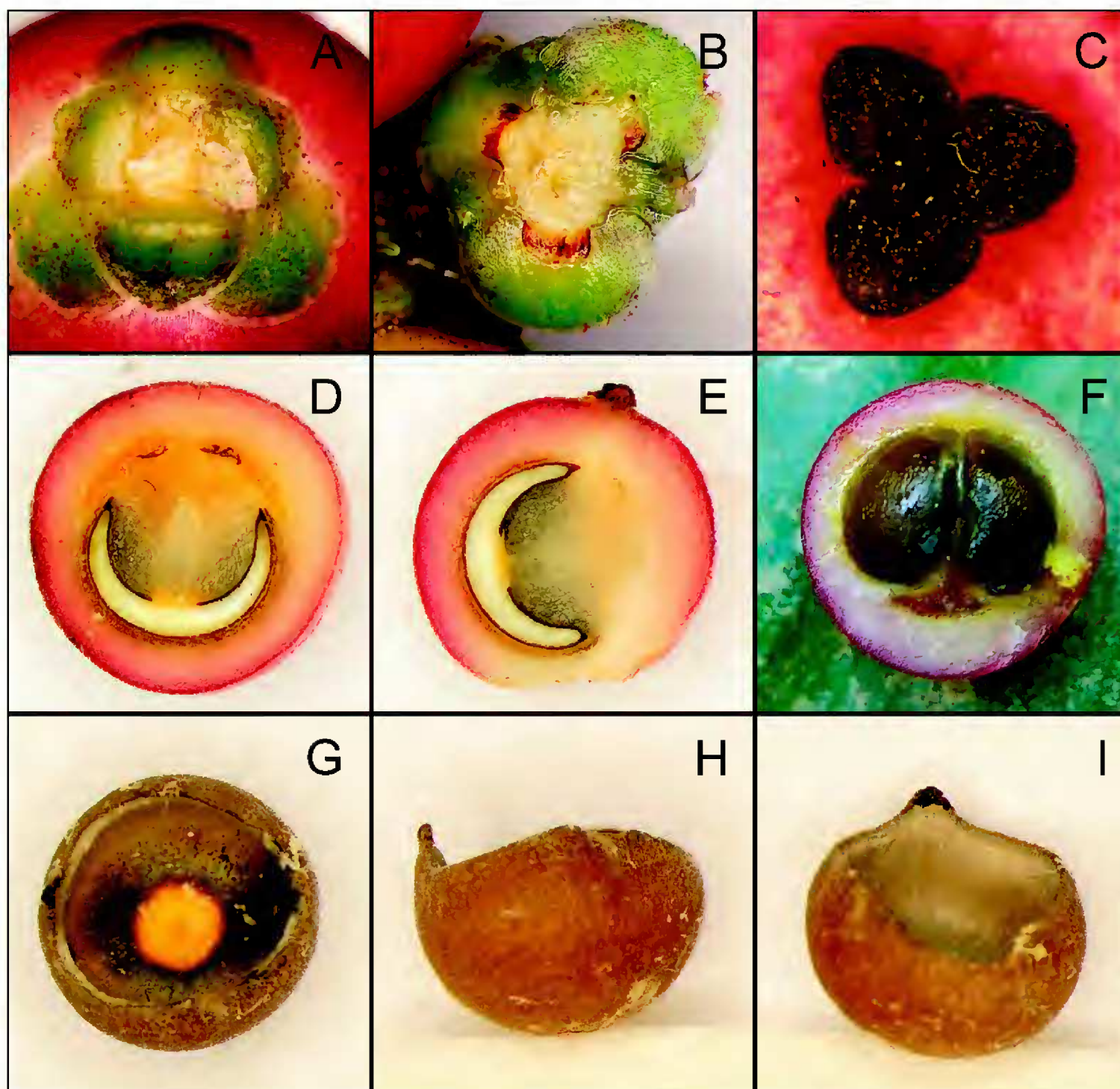


Fig. 7. *Hanguana rubinea* Škorničk. & P.C.Boyce. **A.** Detail of tepals tightly clasping the base of the fruit. **B.** Detail of inner tepals, staminodes and staminodial scales. **C.** Detail of stigma. **D.** Cross section of fruit showing single seed and two empty locules. **E.** Longitudinal section 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 km², 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 unmistakable 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 rachis 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 to 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

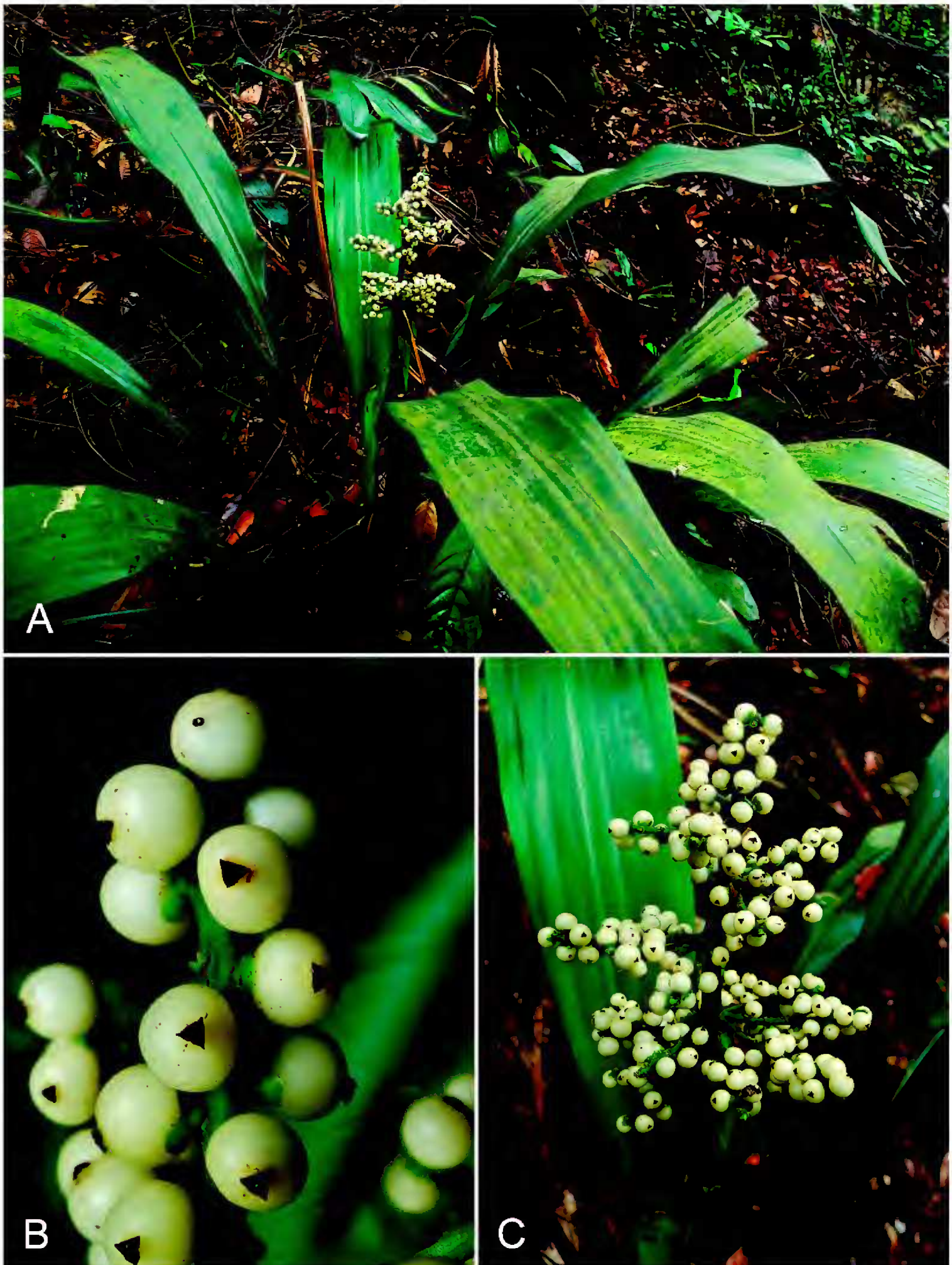


Fig. 8. *Hanguana triangulata* Škorničk. & P.C.Boyce. **A.** Habit. **B.** Detail of fruits and the typical sharply triangulate stigma. **C.** Inflorescence. From type *JLS-2789*. (Photos: Jana Leong-Škorníčková)

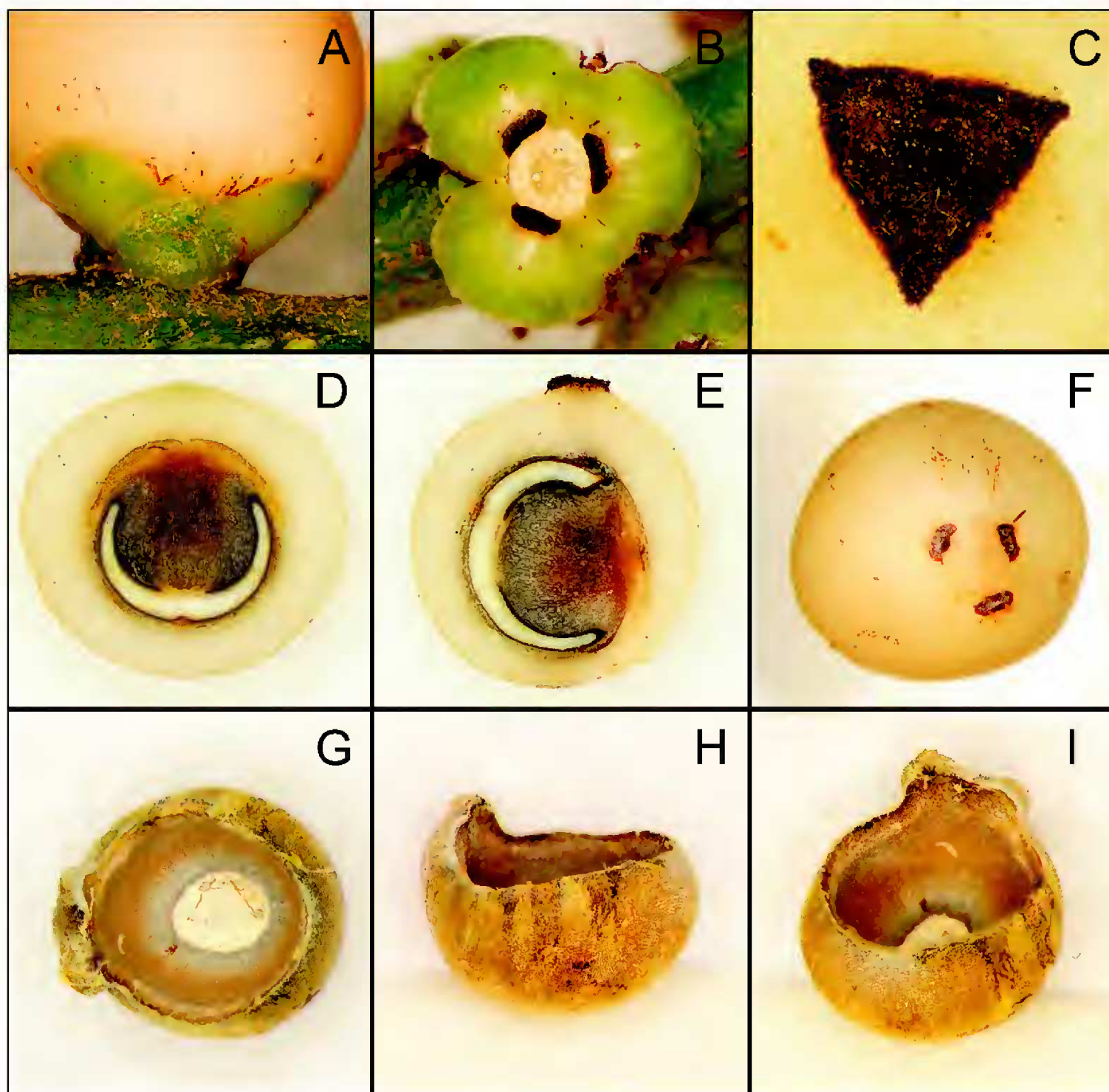


Fig. 9. *Hanguana triangulata* Škorničk. & P.C.Boyce. **A.** Detail of tepals (side view). **B.** detail of inner tepals, staminodes and staminodial scales. **C.** Detail of stigma. **D.** Cross section of fruit showing single seed and two empty locules. **E.** Longitudinal section of fruit. **F.** Fruit 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, $36\text{--}71 \times 6.5\text{--}11.5$ 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 $2/3\text{--}1/2$ 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 $\frac{1}{4}$ – $\frac{1}{3}$ 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. $\frac{3}{4}$ 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., $\frac{3}{4}$ globose to ellipsoid, ostiole wedge-shaped accounting for c. $\frac{1}{4}$ 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). – *Veratonia 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 Nurfaizilah 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)

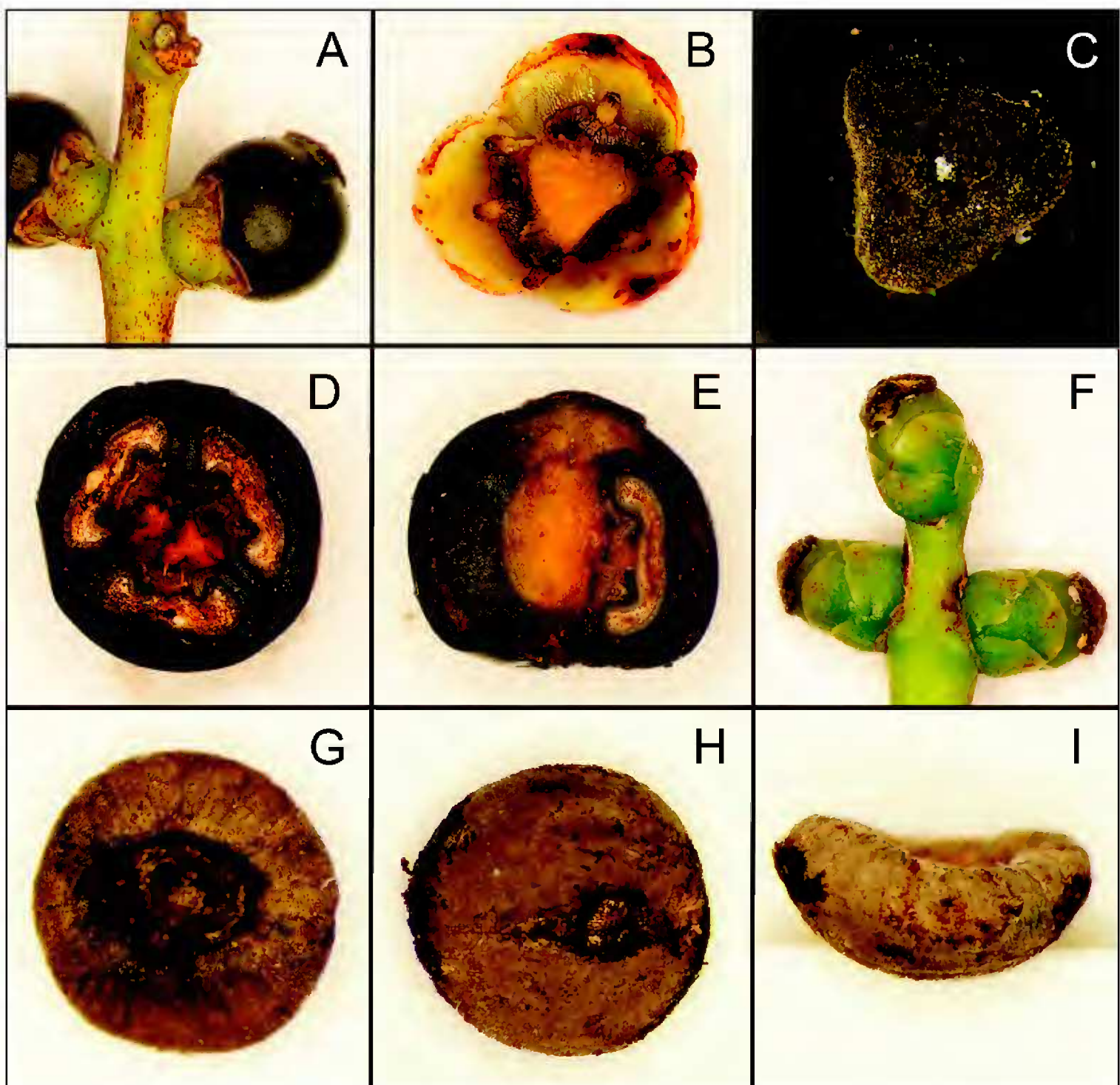


Fig. 12. *Hanguana malayana* (Jack.) Merr. **A.** Detail of tepals clasping base of ripe fruit (side view). **B.** Detail of inner tepals, staminodes and staminodial scales. **C.** Detail of stigma. **D.** Cross section of fruit showing three well-developed seeds. **E.** Longitudinal section of fruit. **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 Nurfaizilah 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 singaporense* 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.

ACKNOWLEDGEMENTS. The first author thanks the National Parks Board, Singapore. Our sincere thanks are due to numerous NParks staff and volunteers, who provided us with continuous support in our taxonomic and conservation research on the Singapore flora, in particular: Desmond Lee, Mishak Sunari (Sungei Buloh Wetland Reserve, field support), Derek Liew, Chew Pin Ting (Central Catchment Nature Reserve, field support), Ang Wee Fong (Horticulture and Community Gardening Division), Aung Thame, Sunia Teo and Michael Leong (Singapore Botanic Gardens, field support and propagation of native species for conservation purposes). We thank Prof. Hans-Juergen Tillich for fruitful discussions and suggestions on the possible origin and function of staminodial scales, and confirmation of the identity of *Hanguana bogneri*, and Dr Saw Leng Guan from the Forest Research Institute, Malaysia for granting access to FRIM's living collections of *Hanguana*, which helped us improve the description of the imperfectly known *Hanguana corneri*. We also thank Eva-Nicole Fisher (volunteer at Singapore Botanic Gardens) for her help with a translation of the research paper by Tillich & Sill (1999) which was originally published in German, and to the anonymous reviewers for useful comments to improve this manuscript.

References

- Airy Shaw, H.K. (1980). A new species of *Hanguana* from Borneo. *Kew Bull.* 5(4): 819–821.
- Bachman, S., Moat, J., Hill, A.W., de la Torre, J. & Scott, B. (2011). Supporting Red List threat assessments with GeoCAT: Geospatial Conservation Assessment Tool. In: Smith, V. & Penev, L. (eds) e-Infrastructures for data publishing in biodiversity science. *ZooKeys* 150: 117–126. (Version BETA)*.
- Backer, C.A. (1951). *Hanguana*. In: Steenis, C.G.G.J. van (ed) *Flora Malesiana*, ser. 1, 4(3): 248–250.
- Bayer, C., Appel, O. & Rudall, P.J. (1998). Hanguanaceae. In: Kubitzki, K. (ed) *The Families and Genera of Vascular Plants*, vol. IV. Pp. 223–225. Berlin-Heidelberg: Springer-Verlag.
- Beentje, H. (2012). *The Kew Plant Glossary, an illustrated dictionary of plant terms* (revised edition). Royal Botanic Gardens, Kew: Kew Publishing.
- Chong, K.Y., Tan, H.T.W. & Corlett, R.T. (2009). *A Checklist of the Total Vascular Plant Flora of Singapore: Native, naturalised and cultivated species*. Singapore: Raffles Museum of Biodiversity Research, National University of Singapore.
- Davison, G.W.H., Ng, P.K.L. & Ho, H.C. (eds) (2008) *The Singapore Red Data Book: Threatened plants and animals of Singapore*, 2nd ed. Singapore: The Nature Society (Singapore).

- Holttum, R.E. (1950). The Zingiberaceae of the Malay Peninsula. *Gard. Bull. Singapore* 13:1–249.
- IUCN (2012). *IUCN Red List Categories and Criteria: Version 3.1*. Second edition. Switzerland, Gland and UK, Cambridge: IUCN.
- Keng, H., Chin, S.C. & Tan, H.T.W. (1998). *The Concise Flora of Singapore, volume II: Monocotyledons*. Singapore: Singapore University Press.
- Leong-Škorničková, J., Thame, A. & Chew, P.T. (2014). Notes on Singapore native Zingiberales I: A new species of *Zingiber* and notes on the identities of two further *Zingiber* taxa. *Gard. Bull. Singapore* 66(2): 153–167.
- Low, Y.W., Leong, P.K.F., Tee, S.P., Rajesh Singh, Tay, M.L.C. & Wong, K.M. (2014). *Margaritaria* (Phyllanthaceae), a new generic record for the Singapore flora. *Gard. Bull. Singapore* 66(1): 47–56.
- Mohd Fahmi, A.B., Ahmad Sofiman, O. & Boyce, P.C. (2012). Studies on *Hanguana* (Commelinales: Hanguanaceae) for Sunda IV: *Hanguana major* clarified, a new species from Sarawak, Malaysian Borneo, and description of male reproductive organs in *H. bakoensis*. *Kew Bull.* 67: 205–211.
- Niissalo, M., Wijedasa, L., Boyce, P.C. & Leong-Škorničková, J. (2014). *Hanguana neglecta* (Hanguanaceae): a new plant species from a heavily collected and visited reserve in Singapore. *Phytotaxa* 188(1): 14–20.
- Rodda, M., Tran, H.D., Chiew, P.T., Liew, D. & Leong-Škorničková, J. (2012). The rediscovery of *Dischidia hirsuta* (Apocynaceae, Asclepiadoideae) in Singapore. *Gard. Bull. Singapore* 64(2): 293–299.
- Rudall, P.J., Stevenson, D.W. & Linder, H.P. (1999). Structure and systematics of *Hanguana*, a monocotyledon of uncertain affinity. *Austral. Syst. Bot.* 12: 311–330.
- Siti Nurfazilah, A.R., Mohd Fahmi, A.B., Ahmad Sofiman, O. & Boyce, P.C. (2010). Studies on *Hanguana* (Commelinales-Hanguanaceae) for Sunda II: Five new forest species, a new species record from Peninsular Malaysia, and a redefinition of the taxonomic limits of *Hanguana malayana*. *Willdenowia* 40: 205–219.
- Siti Nurfazilah, A.R., Ahmad Sofiman, O. & Boyce, P.C. (2011). Studies on *Hanguana* (Commelinales-Hanguanaceae) for Sunda I: *Hanguana bakoensis*, a new forest species from Sarawak, Malaysian Borneo, and notes on critical morphologies for elucidating *Hanguana* taxonomy. *Acta Phytotax. Geobot.* 61(3): 139–143.
- Sugumaran, M. & Wong, K.M. (2014). Studies in Malesian Gentianaceae, VI. A revision of *Utania* in the Malay Peninsula with two new species. *Pl. Ecol. Evol.* 147(2): 213–223.
- Tillich, H.-J. (1996). Seeds and seedlings in Hanguanaceae and Flagellariaceae (Monocotyledons). *Sendtnera* 3: 187–197.
- Tillich, H.-J. & Sill, E. (1999). Systematische studien zur morphologie und anatomie von *Hanguana* Blume (Hanguanaceae) und *Flagellaria* L. (Flagellariaceae). Mit der Beschreibung einer neuen Art, *Hanguana bogneri* spec. nov. *Sendtnera* 6: 215–238.