

Notes on Singaporean native Zingiberales II: revision of Marantaceae, with a new generic record and notes on naturalised and commonly cultivated exotic species

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Abstract

An illustrated revision of Marantaceae in Singapore with an identification key and proposed national IUCN Red List assessments is presented here. In total three genera and four species are considered native to Singapore (*Donax canniformis*, *Phrynium hirtum*, *Stachyphrynium parvum*, and *Stachyphrynium latifolium*) representing 33 % of diversity currently known to occur in Peninsular Malaysia. Although the genus *Phrynium* Willdenow (1797: 1) was previously reported for Singapore based on the presence of *P. villosulum*, we show that this species is, contrary to previous accounts, not native but introduced. Newly reported *Phrynium hirtum* therefore represents a new native generic record for the country. We are changing the status of *Schumannianthus benthamianus*, previously considered native, to cultivated, as there are no historic or recent collections of this species. Non-native species commonly employed in Singapore streetscapes and parks are also briefly discussed and illustrated in this paper. *Actoplanes ridleyi*, *Donax grandis*, *Donax parviflora*, *Maranta tonchat*, *Phrynium latifolium* and *Phrynium sumatranum* are lectotypified and *Maranta arundinacea* Blanco (non L.) is neotypified.

Key words: Bukit Timah Nature Reserve, Central Catchment Nature Reserve, horticulture, IUCN, lectotype, neotype, *Thaumococcus daniellii*, typification

Introduction

Marantaceae, often known as prayer plants, are a family in the ginger order (Zingiberales) with ca. 530–570 species (Andersson 1998, Christenhusz & Byng 2016). The family probably originated in Africa, from where it has spread across the moist tropics (Ley & Claßen-Bockhoff 2011). Marantaceae is now particularly diverse in tropical America, where 80% of the species are found (Kennedy 2000). The remaining diversity is divided between Africa and tropical Asia. Marantaceae is a relatively small family in Asia with eight genera and an estimated 55 species (Suksathan *et al.* 2009).

We have observed and collected specimens of Marantaceae during an ongoing conservation project on the native gingers of Singapore, initiated by the Singapore Botanic Gardens, National Parks Board, in January 2011. The project has already led to the description of *Zingiber singaporense* Škorničk. in Leong-Škorníčková *et al.* (2014) and now includes a thorough survey of primary forest habitat in Singapore (Niissalo *et al.*, in press). The current article is the second part of a series on native Zingiberales from Singapore (following Leong-Škorníčková *et al.* 2014), in which we describe the diversity of Marantaceae, record the discovery of *Phrynium hirtum* Ridley (1899: 181) and bring further light to the presence of *Phrynium villosulum* Miquel (1860: 616) and *Schumannianthus benthamianus* (Kuntze 1892: 684) Veldkamp & Turner (2016: 47). The last two species were previously thought to be native to Singapore, but are now known to have been introduced.

Generic limits in Marantaceae have long been difficult to establish (Andersson 1998), but there has been much progress in delimiting genera with genetic markers (Andersson & Chase 2001, Prince & Kress 2006a, 2006b, Suksathan *et al.* 2009). There are no remaining taxonomic problems at the generic level in Singapore. We are following the most recent generic delimitation by Suksathan *et al.* (2009).

Species-level taxonomy is somewhat more complex in Asia with some of the large and widespread species with high morphological variability likely to consist of several cryptic species. The species native to Singapore are all rather

uniform with no intraspecific variability observed. Here, we follow the broad circumscription of *Donax canniformis* (Forster 1786: 1) Schumann (1892: 440) and *Stachyphrynium latifolium* (Blume 1827: 37) Schumann (1902: 49) as outlined in Suksathan & Borchsenius (2005). The nomenclature and taxonomic identity of *Phrynium hirtum* has been well defined previously. We provide further clarity to the nomenclature of *Stachyphrynium parvum* Ridley (1910: 60), which belongs to a group of poorly understood species, here referred to as the *Stachyphrynium sumatranum* clade. During thorough review of literature and original herbarium material it became clear that a number of names need to be lectotypified and one name is in need of a neotype, which we therefore address in this paper.

While Singapore has only four native species of Marantaceae, the diversity is representative of the region. Only one Malesian genus, *Halopegia* Schumann (1902: 49) from Java, is absent in Singapore. Currently there are 12 native species of Marantaceae in the entire Peninsular Malaysia, including the four species native to Singapore (Malaysian National Biodiversity Clearing House Mechanism 2016; the database reports 14 species but includes *Stachyphrynium latifolium* and *Donax canniformis* under two separate names which are now considered synonymous). This means that 33% of Marantaceae recorded in Peninsular Malaysia can be found in Singapore, a relatively high number given the small area and limited elevational range in Singapore. However, the family is poorly studied in South-East Asia (Andersson 1998, Clausager & Borchsenius 2003, Ardiyani *et al.* 2010, Suksathan *et al.* 2010) and the diversity is likely to increase when further field studies are carried out.

Each of the native and naturalised species and those species previously considered native are illustrated in figures 1–6 and selected cultivated species are illustrated in figures 7–8. More illustrations of Marantaceae cultivated in Singapore can be found in Boo *et al.* (2003, 2014) and in Leong-Škorničková & Gallick (2010).

Materials and methods

We studied type material and specimens collected in Singapore at AAU, B, BM, E, K, L, P, SING, SINU and US. Apart from the material at SING and SINU, our research was limited to digital scans of specimens available online. We also received help from staff at AAU, L, MA, PNH, QBG and US, who checked for the presence of type material in those herbaria and imaged material upon request. We were able to locate type material for all names in use for native taxa in Singapore.

Descriptive terms for Marantaceae morphology vary widely. In this paper we follow the neutral descriptive terminology of Clausager & Borchsenius (2003) and Suksathan & Borchsenius (2003) for vegetative parts of the plants and the synflorescence structure. We are considering all laminate vegetative structures to be true leaves, not bracts, even if they are closely associated with a synflorescence. A differing terminology for flower parts was recently used by Ley & Claßen-Bockhoff (2011) and we are following their terminology for staminodes, substituting “fleshy staminode” for “callose staminode” and “hooded staminode” for “cucullate staminode”. However, we have retained the use of “fertile stamen” to describe the entire structure that holds the single monothebate anther. We are using the term “floral tube” for the fused, tubular portion of petals and stamens/staminodes, and “staminodial tube” for the portion of the floral tube formed by members of androecial whorl that extends beyond the petals. For descriptive morphology, we follow Beentje (2010), except for substituting “narrowly ovate” for “lanceolate” and “narrowly elliptic” for “lanceolate (Lindley)”.

All descriptions are based on material from Singapore that we could study. Flower measurements were taken from freshly collected material and spirit collections, and vegetative measurements were done in the field and supplemented with measurements from dried herbarium material.

We sequenced two DNA regions (ITS1 and *rps16* intron) used previously in a phylogenetic study of Asian Marantaceae (Suksathan *et al.* 2009), using primers described therein to elucidate the relationships and identity of *Stachyphrynium parvum* and an unidentified species at Bukit Timah Nature Reserve. We compared sequence similarity to existing samples in GenBank using BLAST (<https://blast.ncbi.nlm.nih.gov/Blast.cgi>) and subsequently downloaded sequence sets that were aligned and cropped using Muscle (16 maximum iterations and considering maximum one tree). We built trees using neighbour joining (Tamura-Nei distance, 1000 bootstrap replications) and a rudimentary parsimony analysis using PAUP (using heuristic search with standard search settings). Muscle alignment and neighbour-joining were conducted in MacVector (Rastogi 2000) and parsimony analysis in Geneious version 9.0.5 (Kearse *et al.* 2012).

Results

We found herbarium material of all five species of Marantaceae, including three of the four species listed in Singapore's national flora checklist (Chong *et al.* 2009; there was no material of *Schumannianthus benthamianus*) plus a recent collection of *Phrynium hirtum*, the discovery of which has not been published. All species with herbarium material were discovered in the Central Nature Reserves in Singapore, and therefore there are no recorded extinctions in this family. We consider the small population of *Phrynium villosulum* a recent introduction. Other introduced species were discovered in the vicinity of nature reserves, and a second, currently undescribed, species of *Phrynium*, which we have not yet seen in flower, has been introduced to Bukit Timah Nature Reserve.

All native species were seen in flower. The morphology of most species agree with descriptions published in other regional treatments, but we have some reservation about the current wide species concept used in *Stachyphrynium latifolium*, and we shed more light to the *Stachyphrynium sumatranum* clade, which includes one poorly understood species in Singapore, *S. parvum*. We found suitable type material for all names, and were able to select the best available lectotypes or neotypes for all names included in the synonymy of Singapore species.

Conspectus of native Singaporean Marantaceae

1. *Donax canniformis* (G.Forst.) Schumann (1892: 440)

Basionym:—*Thalia canniformis* Forster (1786: 1), as ‘cannaeformis’ $\equiv$ *Actoplanes canniformis* (G.Forst.) Schumann (1902: 34) $\equiv$ *Arundastrum canniforme* (G.Forst.) Kuntze (1891: 683) $\equiv$ *Clinogyne canniformis* (G.Forst.) Schumann (1897: 96) $\equiv$ *Ilythuria canniformis* (G.Forst.) Rafinesque (1836: 51) $\equiv$ *Phrynium canniforme* (G.Forst.) Körnicke (1858: 85) $\equiv$ *Phrynium canniforme* (G.Forst.) Schrank (1824: 178), *nom. illeg., non* Körnicke (1858: 85). $\equiv$ *Phrynium dichotomum* Roxburgh (1810: 324), *nom. inval.* $\equiv$ *Clinogyne dichotoma* Salisbry (1812: 276), *nom. inval.* $\equiv$ *Clinogyne dichotoma* Benth (1883: 651), *nom. inval.* $\equiv$ *Maranta dichotoma* Dietrich (1831: 17).

Type:—VANUATU. Mallicollo, [Nov. Hebrid. Mallicollo], without date, *J.G.A. Forster s.n.* (lectotype BM! [BM000632825], first step designated by Rolfe 1907, second step designated by Veldkamp & Turner 2016).

= *Donax arundastrum* Loureiro (1790: 11) $\equiv$ *Maranta arundastrum* (Lour.) Almeida (2009: 111). Type: VIETNAM. Cochinchina [Southern Vietnam], without date, *J. de Loureiro s.n.* (lectotype BM! [BM000632823], designated by Rolfe 1907).

= *Maranta tonchat* Blume (1827: 36). Type: INDONESIA. Java, without date *C.V. Blume s.n.* (lectotype L! [L1482450], **here designated**, isoelectotypes L! [L1482442, L1482443, L1482444, L1482451, L1482452], BO?).

= *Maranta arundinacea* Blanco (1837: 5), *nom. illeg., non* Linnaeus (1753a: 2). Type: PHILIPPINES, Palawan, Tayao, May 1913, *Merrill Species Blancoanae No. 279* (neotype US! [US00346027], **here designated**, isoneotypes L! [L1482266] P! [P02199296]).

= *Maranta grandis* Miquel (1860: 616) $\equiv$ *Actoplanes grandis* (Miq.) Schumann (1902: 34) $\equiv$ *Arundastrum grande* (Miq.) Kuntze (1891: 684) $\equiv$ *Clinogyne grandis* (Miq.) Baker (1892: 258) $\equiv$ *Donax grandis* (Miq.) Schumann (1892: 440) $\equiv$ *Donax grandis* (Miq.) Ridley (1899: 176), *nom. illeg., non* Schumann (1892: 440). Type: INDONESIA. Sumatra, Palembang, without date, *J.E. Teijsmann s.n.* (lectotype K! [K000292262], **here designated**, isoelectotype L! [U0282853], BO?).

= *Actoplanes ridleyi* Schumann (1902: 35). Type: Burma and Malay Peninsula, without precise locality or date, *W. Griffith 9784* (lectotype L! [L1482521], **here designated**).

= *Donax parviflora* Ridley 1910: 59. Type: MALAYSIA. Selangor, woods at the base of Batu Caves, August 1908, *H. N. Ridley 13393* (lectotype K! [K000292264], first step (“SING”) designated by Holttum (1951; see further notes below), **second step lectotype here designated**, isoelectotypes BM! [BM000617230], K! [K000292263]).

Rhizomatous, herbaceous, terrestrial shrub with tall, branching aerial stems 2.0–4.5 m, each stem protected at the base by a papery bract ca. 20–30 cm, after which there are no internodes or leaves until the height of 1.0–2.5 m, at which point the plant branches out to many secondary branches, which branch further to produce numerous leaves, the length of internodes decreases as the order of branches increases. Leaf sheath 7–20 cm, green, glabrous except for a few hairs at the very base and adjacent to the pulvinus; petiole absent; pulvinus 1–4 cm; lamina oblong-ovate, 15–38 $\times$ 8–21 cm, apex acuminate, acumen 0.5–1.0 cm, base rounded, upper leaf surface medium to dark green, glabrous, lower surface light green, glabrous except for a pubescent narrow strip close to the midrib (top of midrib glabrous). Inflorescence terminal, several (three to many) emerging at the base of a leaf near the apex of the stem, spreading, base obscured by an enveloping leaf sheath; peduncle absent or very short; bract at the base of the synflorescence 5–10 $\times$ 0.8–1.0

cm, often absent (deciduous?); synflorescence heavily branched, lax, 11–20 cm; with variable orders of branching, each branch producing 10–20 fertile bracts, each fertile bract with a single flower-pair or a new branch, fertile bracts linear, narrow, deciduous, acute, 2.5–4.0 × 0.5–0.8 cm, tomentose, light green, soon drying to straw-yellow and papery, prophyll 18–22 × 2–4 mm, interphyll absent; Flower pair axes 1.5–4.0 cm to the lowest flower, pedicel of individual flowers 3–6 mm, with a short and very thick bracteole (which functions as an extrafloral nectary), 2.5 × 2.5 mm. Flower 1.7–1.9 cm long, with a very faint scent of jasmine; sepals 3, free, subulate with a distinct basal thickening, glabrous except for a few long hairs at the thickening, 5 × 0.5 mm, white; floral tube 6–7 mm long, incompletely fused; petal lobes equal, elliptic, acute, 10–12 × 5–6 mm, white, with a translucent margin, reflexed; staminodial tube 2–3 mm longer than the floral tube; outer staminodes 2, almost equal, free part of both staminodes elliptic, white with a slightly yellow margin, rolled in bud, only apex slightly crumpled, 9–10 × 2.5–4.5 mm; hooded staminode cucullate, almost white, free part 4 × 2.7 mm, appendix recurved, sulphur-yellow, ca. 2 × 1 mm; fleshy staminode almost tubular, opening up towards the apex, white, sulphur yellow towards to apex, free part 7–8 × 5–7 mm, with a tall and thin, sail-like white appendix that curves along the margin, 3 × 2 mm; fertile stamen 4.5 × 1.7 mm (including the fertile anther and appendage), recurved, linear with a blunt tip, anther emerging at 2.0–2.5 mm measured from the base of the free part of the stamen, 1.7 × 0.6 mm; style with a 4 mm free part, curved inwards, asymmetrical with several lobes towards the apex, stigmatic cavity ca. 1 mm diameter; ovary globose, 1.8–2.4 × 1.9–2.1 mm, light brown, sericeous. Fruits globose, 10–12 mm in diameter, sericeous when young, maturing almost glabrous; only one seed develops (the other two can be seen as aborted seeds in mature fruit), aril absent.

Provisional IUCN conservation assessment:—Least Concern (LC). This species is widespread in the Malesian region, West to the Andaman and Nicobar Islands, North to Indochina and Southeast to Oceania. The species is capable of growing in disturbed habitats (Clausager & Borchsenius 2003) and the population is globally not known to be decreasing. There are hundreds of collections made during the past thirty years.

In Singapore *D. canniformis* is nationally Critically Endangered (CR), under criterion D, as only ca. 40 clumps (each currently best considered to consist of a single individual) are known in a small area (one location, five localities) in forested habitats in the boundaries of Bukit Timah Nature Reserve. Because the species is very robust, it may appear abundant and dominant in small areas. As the species roots easily at leaf nodes and is therefore capable of vegetative spread, it is not yet known how many genetically distinct individuals are present in Singapore. There are only two records supported by specimens from Pulau Ubin, both very recent (2011 and 2012) from a single locality which is in the proximity of a village, and therefore its native status remains highly doubtful, considering that this species is often planted.

Specimens examined:—SINGAPORE. **Bukit Timah:** without date, *Mohd Noor 1803* (SING); April 1885, *R.W. Hullett 440* (SING); Taban Valley, 24 June 1994, *S.C. Lee BT011* (SINU); Taban Valley, 19 July 1994, *S.C. Lee BT027* (SINU); Tiup Tiup Path, 12 October 1995, *Eugene Tang & Hj. Sidek 997* (SING); 23 May 2013, *J. Leong-Škorničková & V. Gowda SNG-157* (SING); Dairy farm Loop, 9 March 2016, *M.A. Niissalo, A. Thame, D. Liew & S. Teo SNG-343* (SING); Dairy farm Loop, 9 March 2016, *M.A. Niissalo et al. SNG-342* (SING); Tiup Tiup Path, 8 April 2016, *M.A. Niissalo et al. SNG-333* (SING). **Bukit Panjang:** 10 January 1889, *H.N. Ridley 86* (SING). **Kranji:** 1894, *H.N. Ridley s.n.* (SING). **Without locality:** 1883, *R.W. Hullett s.n.* (SING); without date, *N. Cantley's Collection s.n.* (SING).

Probably introduced material:—Pulau Ubin: 11 February 2011 *H.D. Tran et al. SNG-041* (SING); Bukit Jelutong, 2 October 2012, *Ali Ibrahim & J. Lai SING 2012-271* (SING).

Notes:—*Donax canniformis*, as currently circumscribed, is an extremely widespread species. Due to the perishable nature of flowers, which are rarely present in herbarium material, previously published synonymies are mostly based on comparison of leaves, fruits and inflorescence branching that vary widely. We have reviewed all available type material associated with names currently linked to this taxon and largely agree with previous treatments (Suksathan & Borchsenius 2005, The Plant List 2013), although it is possible that one synonym, *Donax parviflora*, might need to be resurrected after fresh flowering material is recollected. We have also excluded *Arundastrum benthamianum* Kuntze (1891: 684). This name, here used for an unrelated taxon, was recently discussed by Veldkamp & Turner (2016).

In Singapore native populations of *D. canniformis* are restricted to Bukit Timah Nature Reserve and its immediate surroundings. The previously recorded habitats in Bukit Panjang and Kranji no longer contain primary forest, and although the species is known to also inhabit secondary forests populations these may be of introduced origin. It could possibly be found in Singapore in the Central Catchment Nature Reserve, the species has been often planted from unknown origin, sourced from local nurseries. Therefore, plants found in secondary habitat are best to be treated as introduced as they are probably genetically different from the local stock.



FIGURE 1. *Donax canniformis*. A. Habit. B. Inflorescence. C. Detail of flowers (side view). D. Detail of flowers (front view). E. Infructescence with detail of seeds (in inset, scale in mm). F. Detail of flowers in dorsal view, also showing the bracteoles. Based on SNG-333. (Photos: Jana Leong-Škorníčková)

Two sterile collections of this species from Pulau Ubin were mistakenly identified as *Schumannianthus benthamianus*, but can be safely determined as belonging to *Donax canniformis* by their much larger laminae (over 20 cm long) and by the presence of a narrow pubescent line positioned immediately adjacent to the midrib abaxially. More details on these collections are mentioned under *Schumannianthus benthamianus*.

Typification:—*Maranta arundinacea* Blanco *non* L.: There are very few specimens by Blanco or other contemporary collections from the Philippines (Veldkamp 1989). We have not found any of Blanco's contemporary material of *Maranta arundinacea* Blanco at the most likely herbaria, MA, P, G or L, and it is unlikely that any were collected and survived. We agree with Merrill (1918) that *Maranta arundinacea*, illustrated in the third edition of Blanco's flora, an illegitimate later homonym of *M. arundinacea* L., is a synonym of *Donax canniformis*. Merrill's "illustrative specimens" are not considered valid neotypifications (Nicolson & Arculus 2001) and we therefore formalise neotypification of the name using Merrill's collection of *Donax canniformis* at US.

Actoplanes ridleyi K.Schum.: The material cited by Schumann for the description of *Actoplanes ridleyi* were most certainly at B, but as with all other Zingiberales specimens, these have been lost during WWII. We found very few specimens in other herbaria that could be original material or from the same locality. Schumann cited Kurz collections from Tenasserin and Andaman, and Scortechini, Ridley and Schottmüller collections from Peninsular Malaysia ["Halbinsel Malakka"] in the protologue. No relevant material by Kurz, Scortechini, Ridley or Schottmüller survived at B. There are three specimens by Scortechini, one each at L, P, and SING, at least one pre-dating Schumann's publication, and a few collections by Ridley from Peninsular Malaysia that pre-date Schumann's work, all annotated as *Donax parviflorum*. It is not clear if any of these are from same collections as the material seen by Schumann. We have checked all material for *Donax* Loureiro (1790: 1) we could locate, and the only specimen determined in Schumann's handwriting as *Actoplanes ridleyi* is a Griffith specimen that pre-dates the publication of *A. ridleyi* (it was distributed to K in 1963–1964), but which is not cited in the protologue. However, Schumann's determination slip is labelled as "Bearbeitet für das 'Pflanzenreich'", which was the place of publication of *Actoplanes ridleyi*. The material is clearly part of the uncited original material, and unambiguously the best suitable lectotype available for this name. Schumann's description may have been based on mixed material, as his description in general fits *Donax canniformis*, but he states that *A. ridleyi* only rarely has a single seed in the fruit, usually more. Some of the fruiting specimens Schumann saw may have been of *Schumannianthus benthamianus*, which usually has up to three seeds per fruit. However, we have been unable to find any *Schumannianthus* specimens identified by Schumann as *A. ridleyi*.

Donax parviflora Ridl.: Holttum (1951) selected the collection Ridley 13393 as the lectotype of this name, stating that all material seen of this species is in the Singapore Herbarium. However, no material of this collection number could be found at SING and there is no record of it in the card index at SING. Turner (2000) cites the location of the lectotype as K, where there are two specimens of this collection. One of the specimens has been transferred from what appears to be a SING herbarium sheet (still seen on the background) onto a K sheet. This collection might be an unreturned loan (or gift) from SING to K, and was most likely the specimen originally selected by Holttum who worked at K. We have therefore selected it as the lectotype of this name in a second-step lectotypification, since there are now two sheets of the same collection present at K. The other specimen is an isoelectotype.

Donax grandis Miq.: While two collections (identifiable by location details and handwriting attributed to J.E. Teijsmann) at L and K are almost certainly duplicates, and the sheet at L (originally from Utrecht) also probably originates from Miquel's herbarium, we have selected the collection at K as the lectotype, since it is explicitly collected by Teijsmann, and carries a label clearly identifying it as part of Miquel's herbarium.

Maranta tonchat Blume: The most complete specimen was selected from known collections by Blume at L.

2. *Phrynium hirtum* Ridley (1899: 181)

Type:—MALAYSIA. Johore, Gunong Panti, December 1892, *H.N. Ridley s.n.* (lectotype SING! [SING0049873], first step designated by Holttum [1951], second step designated by Turner [2000]).

= *Phrynium inflatum* Merrill (1922: 164). Type: MALAYSIA. Sabah, Batu Lima near Sandakan, September–December 1920, *M. Ramos* 1488 (lectotype US! [US00093128], **here designated**, isoelectotype K! [K000292226]).



FIGURE 2. *Phrynium hirtum*. A–B. Habit, detail of lower side of the lamina in inset. C. Detail of inflorescence (side view). D. Detail of flowers (front view). E. Detail of fruit and seeds (scale in mm). F. Detail of infructescence. Based on SNG-348. (Photos: Jana Leong-Škorníčková)

Rhizomatous, rosulate terrestrial herb to 1.2–1.3 m. Leaves ca. 6 per shoot; sheath 30–34 cm, green to yellow-green, hirsute; petiole 21–35 cm, green to yellow-green, glabrous; pulvinus 6–8 cm; lamina oblong to elliptic, 35–55 × 12–16 cm, apex acuminate, acumen 1.5–2.0 cm, rounded, upper leaf surface dark green, glabrous (including midrib), lower surface light green, flushed with pink when young, maturing purplish green (only green in old leaves), glabrous except for a pubescent midrib. Inflorescence terminal on a leafy shoot, on top of a 60–70 cm long stem, with a single large vegetative leaf (sheath 9–14 cm, petiole absent to ca. 5 cm, lamina 34 × 11 cm); peduncle largely obscured by an enveloping leaf sheath, 2.0–4.5 cm, thickly covered in long hirsute, sometimes flocculose hairs, light yellow-green; synflorescence bract 8.5–9.0 × 2.8–3.0 cm, dry and light brown at flowering time, hirsute; synflorescence capitate with overlapping bracts and branches, spiral, 3–5 cm long; first order branches 2–5, capitate, spiral, 3–4 cm long (mostly composed of bracts, stems very short, ca. 1.5–2 cm), further branched (order of branching is difficult to follow due to complex branching and a compressed inflorescence), fertile bracts 2–4 per terminal branch, spiral, highly lacerate, somewhat elliptic and mildly cupulate, tip usually decayed at flowering, 2.5–3.0 × 1.5–2.0 cm, pale to yellow-green at base, but quickly decaying at apex, hirsute; flower pairs 2–3 per special paraclade, associated prophylls 18 × 10 mm, with two distinct keels on the abaxial surface, interphylls 1–3, linear, 12–15 × 5 mm, sometimes with a minute interphyll close to the prophyll, 7 × 3 mm; flowers sessile, each with a very thin, transparent bracteole, ligulate, 19 × 3 mm. Flower 2.2–2.5 cm long, not fragrant at least during the day; sepals three, free to base, subulate, 14–16 × 2.5–3 mm, semi-translucent cream-white at base, light brown towards the tip, hirsute; floral tube 14 mm, cream white; petal lobes elliptic to oblong, obtuse, 10 × 4 mm, semi-translucent pale orange, less translucent at the centre of the lobe, reflexed to a tight curl that is difficult to force open; staminodial tube as long as the corolla tube; outer staminodes two, slightly unequal in size, both narrowly elliptic, obtuse, apparently crumpled in bud, but opening almost smooth, slightly recurved, soon drying upon collection, white with a few semi-translucent lines at base, sometimes with a faint pale yellow tinge towards the apex (visible especially once the flowers start to dry up), with a free part of 9 × 2.5 (smaller) or 10 × 4 mm (larger); hooded staminode cucullate, curved towards one side, cream-white, yellow towards apex, the free part 5–6 × 4.5–5.0 mm, appendix petaloid, 1.5 × 2 mm, light yellow; fleshy staminode almost tubular, cannot be spread open without destroying, cream-white, pale orange towards apex, with a free part of 5.5–6.0 × 3.0–3.5 mm, glabrous unequally bilobed at apex, lobes recurved, staminode with two appendices, one sail-like, 2.5 × 2 mm glabrous, the other (more basal) callose, hirsute, 4 × 1.2 mm; fertile stamen small, almost fully reduced to a single thecae, 5 × 2 mm, appendix reduced, only present as a flap on the side of the stamen, 1.2 × 0.8 mm; style with a free part ca. 4 mm long, heavily curved inwards, partially fused with the fertile stamen, stigmatic cavity ca. 0.8 mm in diameter; ovary cylindrical, ca. 2 mm long, straw yellow, sericeous. Fruits irregularly globose with finely rugose surface, ca. 12 mm in diameter, with a few long hairs, maturing from green through orange-yellow to almost brown-black; seeds 1–3, light brown, arillate, aril cream-white, composed of base and two subulate (but folded at base) appendages, ca. 4 mm long.

Provisional IUCN conservation assessment:—Least Concern (LC). The species has a broad distribution in northern Malesia, ranging from Peninsular Malaysia to Sumatra and Borneo, but it appears to be restricted to primary forests and its range may be declining rapidly due to reduction in area of suitable habitat. Aside from two recent collections from Singapore, we know of 12 collections from the past 20 years, all collected from Borneo and deposited at AAU and SING. The number of collections suggests that the species may be locally common, though more information of its abundance and range is needed. The species is likely to be under-collected in Sumatra and Peninsular Malaysia, but we may have missed collections as we were unable to visit local herbaria during this project.

In Singapore, the species is nationally Critically Endangered (CR) under criterion D, as only ten individuals are known from a single location.

Specimens examined:—SINGAPORE. MacRitchie: 23 November 2012, Y.S. Yeoh SING 2012-499 (SING); 1 June 2016, J. Leong-Škorničková *et al.* SNG-348 (SING, incl. spirit material).

Notes:—This species has not been reported from Singapore in previous literature. We discovered the only known population of this species during our May 2015 surveys in MacRitchie, in the Central Catchment Nature Reserve, Singapore, when it was in fruiting stage. It flowered in June 2016, after unusually dry preceding months. There is an older collection from MacRitchie, collected in 2012, which lacks further field notes and it is not clear if it comes from exactly a same spot, or if it represents a second population. The population from where our collection originates is in well-preserved primary forest with an unusually high concentration of native Zingiberales (*Elettariopsis latiflora* Ridley [1899: 154], *Globba leucantha* Miquel [1860: 612], *Hornstedtia leonurus* Retzius [1791: VI/18], *H. scyphifera* [Retzius, 1971: III/68] Steudel [1840: 776], *Stachyphrynium latifolium*, *Zingiber puberulum* Ridley [1899: 130] and the recently described Singaporean endemic *Z. singapurensis*), healthy populations of other very rare forest herbs (*Codonobea platypus* [Clarke, 1883: 94] C.L.Lim in Kiew & Lim [2011: 267] and *Staurogyne kingiana* Clarke [1908:

637]) and no introduced herbaceous species. We therefore have no doubt that the species is native to Singapore. Its discovery in Singapore fits well in the previously recorded distribution range of this species.

Because *Phrynium* has only been previously reported for Singapore by mistake (see notes for *Phrynium villosulum* below), *Phrynium hirtum* is a new native generic record for Singapore, a very rare occurrence in this very well-collected tropical country (Niissalo *et al.* 2014).

Typification:—*Phrynium inflatum* Merr.: Clausager & Borchsenius (2003) identified the *A. Ramos 1488* specimen at K as the holotype of *P. inflatum*, but as there are at least two specimens of this collection (K and US). We have designated the US specimen as the lectotype for this name, as it has the note “Type” in Merrill’s handwriting. Merrill was based in Manila (PNH) while writing the protologue, but the type material has probably been distributed later as there are no remaining specimens at PNH.

3. *Stachyphrynium latifolium* (Blume) Schumann (1902: 49)

Basionym:—*Phrynium latifolium* Blume (1827: 37) $\equiv$ *Phyllodes laxifolia* (Blume) Kuntze (1891: 695). Note: *Phyllodes* Loureiro (1790: 13) is a rejected name.

Type:—INDONESIA. Java, Bantam [Banten province], without date, *C.V. Blume s.n.* (lectotype L! [L1486181], **here designated**).

= *Hitchenia musacea* Wallich ex Baker (1892: 225) $\equiv$ *Curcuma musacea* Wallich (1832: Cat. No. 6596), *nom. nud.* Type: SINGAPORE. Singapore, 1822, *N. Wallich 6596* (lectotype K-WALL! [K001124261], designated by Suksathan & Borchsenius 2005, isolectotypes BR! [BR0000013330897]).

= *Stachyphrynium cylindricum* Schumann (1902: 49) $\equiv$ *Phrynium cylindricum* Ridley (1899: 178), *non* Roscoe (1828: table 40), *nom. illeg.* Type: MALAYSIA. Perak, Kwala Dipang, 1898, *Ridley 9787* (lectotype K! [K000292270], designated by Turner 1998).

= *Phrynium griffithii* Baker (1892: 260) $\equiv$ *Stachyphrynium griffithii* (Baker) Schumann (1902: 49) $\equiv$ *Phrynium spicatum* Griffith (1851: 408), *non* Roxburgh (1820: 5), *nom. illeg.* Type: MALAYSIA. Malacca, without date, *W. Griffith s.n.* (lectotype K! [K000292272], designated by Suksathan & Borchsenius 2005).

Rhizomatous, rosulate terrestrial herb to 1–2 m. Leaves 2–4 per shoot; sheath 25–38 cm, pale green, light to dark brown near the margin, glabrous; petiole 30–105 cm, bright green, glabrous; pulvinus 4.5–6.0 cm; lamina oblong, 28–53 $\times$ 10–17 cm, apex acuminate, acumen 2.5 cm, base rounded to truncate, upper leaf surface dark green, glabrous, lower surface glaucous-green due to a waxy coating that is absent from one margin, where a bright green strip 1–2 cm wide is present, glabrous. Inflorescence radical, protected at the base with several narrow bracts increasing in size from 1–2 cm to 6–10 cm; peduncle 8–25 cm, glabrous, pale to yellow-green; bract at the base of the synflorescence 3–7 $\times$ 2.5–3.0 cm, with several basal thickenings (visible in dried material only); synflorescences spiciform, distichous, flattened, 8.5–21 cm; fertile bracts 8–17, each supporting one special paraclade, elliptic, obtuse with a very small acumen, 3.5–4.0 $\times$ 2.5–3.2 cm, pale green to yellow-green, glabrous; flower pairs 3–4 per special paraclade, associated prophylls, elliptic, semi-translucent light brown, glabrous 20–28 $\times$ 10–12 mm, sometimes with two keels, interphyll not always present, when present, ligulate, semi-translucent light brown, glabrous 17–22 $\times$ 2.5 mm; flower-pair shortly pedunculate (2 and 1 mm respectively). Flower ca. 3.7 cm long, with a jasmine fragrance; sepals three, free, subulate, 5 $\times$ 0.8 mm, semi-translucent white at the base, pale brown towards the apex, glabrous; floral tube 26–28 mm long, white, glabrous; petal lobes elliptic with acute apex, 9–11 $\times$ 4 mm, semi-translucent white, recurved; staminodial tube as long as the corolla tube; outer staminodes two, unequal in size, both spatulate, crumpled in bud, white, with a free part of 9 $\times$ 7 mm (larger) or 5 $\times$ 2.5 mm (smaller); hooded staminode slightly cucullate, white, yellow towards the apex, the free part 5 $\times$ 3 mm, with a minute appendix on one side, recurved, triangular, bright yellow, ca. 0.7 $\times$ 0.7 mm; fleshy staminode fused with fertile stamen for almost the entire length, curved but not very strongly tubular, white, with a free part of 5.5 $\times$ 3.6 mm, with a callose, hirsute appendix near base, and a keel-like appendix between the fleshy staminode and the fertile stamen; fertile stamen spatulate, similar in appearance to outer staminodes, 4.2–5.0 $\times$ 2.5–3.0 mm (measured from where it separates from the fleshy staminode), anther theca emerging at the point of separation of the fertile staminode and fleshy staminode, but fused to the appendix of the fertile staminode for its entire length, 1 $\times$ 0.7 mm; style with a free part 4 mm, curved to resemble a crescent, stigmatic cavity facing down at an angle ca. 1.2 mm in diameter; ovary cylindrical to weakly obovate, ca. 1.7 $\times$ 1.2 mm, cream-white, hirsute. Fruits (described from photographic material) elliptic, 30 $\times$ 18 mm, yellow-green, indumentum not seen; seeds 1–3, 25 $\times$ 9 mm, dark brown with rugose surface, arillate at base, aril white, extending into 2 curled subulate appendages, opening as the fruit dehisces, up to 13 mm.



FIGURE 3. *Stachyphrynium latifolium*. A. Base of the plant with inflorescences. B. Habit, detail of lower side of the lamina in inset. C. Detail of inflorescence. D. Detail of flowers in bracts (front view). E. Detail of flowers in bracts (side view). F. Detail of fruits and seeds. G. Fruit, still positioned in bract. H. Flower pair in bract. Based on *SNG-019* and *SNG-084*. (Photos: Jana Leong-Škorničková)

Provisional IUCN conservation assessment:—Least Concern (LC). As currently circumscribed by Suksathan & Borchsenius (2005), this highly variable species has a broad distribution from Thailand through Peninsular Malaysia to Java and Borneo, and there are numerous recent collections across this range. Although it seems to tolerate some slight habitat disturbance, it is likely to have lost substantial parts of the habitat to forest clearance in the region. If the taxonomic status of this taxon changes, the conservation status must be re-assessed.

In Singapore *S. latifolium* is the most common Marantaceae, but the population size is fewer than 250 individuals and it is Endangered (EN) under criterion D.

Specimens examined:—SINGAPORE. **Bukit Timah:** 12 August 1889, *J.S. Goodenough s.n.* (SING); 5 April 1890, *H.N. Ridley 44* (SING); 20 November 1899, *H.N. Ridley 444* (SING); 16 August 1983, *H. Kennedy & E.P. Tay s.n.* (SING, 3 sheets); Fern Valley Trail, 17 October 1995, *Eugene Tang & Hj. Sidek 1005* (SING); Taban Loop, 27 June 1998, *L.M.J. Chen LCMJ 244* (SING); Taban Valley, 30 March 2005, *J. Škorničková et al. SING 2005-54* (SING, 3 sheets and spirit material); Tiup Tiup Path, 24 May 2011, *J. Leong-Škorničková & H.D. Tran, SNG-84* (SING); Tiup Tiup Path, 14 April 2015, *J. Leong-Škorničková et al., SNG-335* (SING). **MacRitchie:** sector 43, 10 June 1992, *S.E. Liaw et al. 1283* (SING, SINU); Off Shinto Trail, 29 May 2014, *J. Leong-Škorničková et al., SNG-184* (SING), MacRitchie Nature Trail, 1 June 2016, *M.A. Niissalo et al. SNG-346* (SING). **Nee Soon:** Nee Soon Freshwater Swamp Forest, in the forest on slope above stream, 26 June 2005, *J. Škorničková et al., SING 2005-250* (SING). **Pulau Seletar:** 1891, *J.S. Goodenough s.n.* (SING). **Sungei Buloh:** 8 May 1890, *J.S. Goodenough s.n.* (SING); 1894, *H.N. Ridley s.n.* (SING). **Without precise location:** 1822, *N. Wallich 6596* (BR, K). **Probably cultivated material:** Botanic Gardens Jungle, 19 April 1962, *Jumali bin Kafrawi 3434* (SINU).

Notes:—The species is morphologically uniform and the measurements are based on the most complete collections (SING 2005-250, *Eugene Tang & Hj. Sidek 1005*, SING 2005-54; *J.S. Goodenough s.n.* 1890) as well as measurements taken from fresh material and in the field. While the species is fairly well represented in Singaporean herbaria, the only collections from Singapore in herbaria abroad are those by Wallich.

With some hesitation, we are following the very wide species delimitation of *S. latifolium* Suksathan & Borchsenius (2005). The population in Singapore is identical to type material of *S. griffithii*, a name often applied to Singaporean material. We acknowledge that a revision of the living flowering material across the region, combined with DNA studies are needed to address if *S. cylindricum* and *S. griffithii* are indeed conspecific with *S. latifolium*, but due to lack of sufficient material, we are currently unable to test this. The species is fairly abundant in the small remaining primary forests in Singapore, both in freshwater swamp forests and the more humid parts of lowland dipterocarp hill forests; a few individuals are known near streams in secondary forests.

The species is easily identified even when sterile in Singapore due to a distinct glaucous surface with a darker wide margin on the underside of mature, but not old, leaves (fig. 3b, inset). While all recent voucher specimens are from Bukit Timah Nature Reserve, MacRitchie Reservoir and Nee Soon, the species occurs throughout the northern part of the Central Catchment (Upper Seletar, Upper Peirce, Ecolink), from where there are currently only silica dried collections at SING.

Typification:—*Phrynium griffithii* Baker: Suksathan & Borchsenius (2005) proposed a *Griffith* collection without a collection number from Malacca deposited at K as the lectotype and also indicated the presence of an isotype (= isolectotype) at K. There are three collections by Griffith from Malacca at Kew. From the collection style and coloration of the specimens it is likely that they are duplicates, although it is difficult to establish such a fact with certainty. Two sheets were part of Hooker's herbarium and have a number of the late East India Company's herbarium 5771 and 59771 respectively (the '9' being likely a type error). The third sheet [K00292272], which was part of Bentham's herbarium, is without a number. This sheet is therefore most likely the intended lectotype by Suksathan & Borchsenius. The other two collections present with a collection number are perhaps better considered syntypes.

Phrynium latifolium Blume: There are three *Blume* specimens at L. One of these matches the protologue with the vernacular name that is written on the sheet ("*pattot*", L0041064!) and another matches the protologue locality data on the sheet ("*Bantam*", L1486181!). The third specimen lacks annotations. As it is not clear if these three sheets are duplicates, we have selected the specimen with matching locality as the lectotype and we consider the other two sheets syntypes.

4. *Stachyphrynium parvum* Ridley (1910: 60) ≡ *Phrynium parvum* (Ridl.) Holttum (1951: 283) ≡ *Stachyphrynium minus* Ridley (1907: 59), non Schumann (1902: 48), nom. illeg.

Type:—SINGAPORE. Reservoir, 1906, *H.N. Ridley 12565* (lectotype SING! [SING0040953], designated by Holttum [1951], isolectotypes BM! [BM000617238], K! [K000292269]).

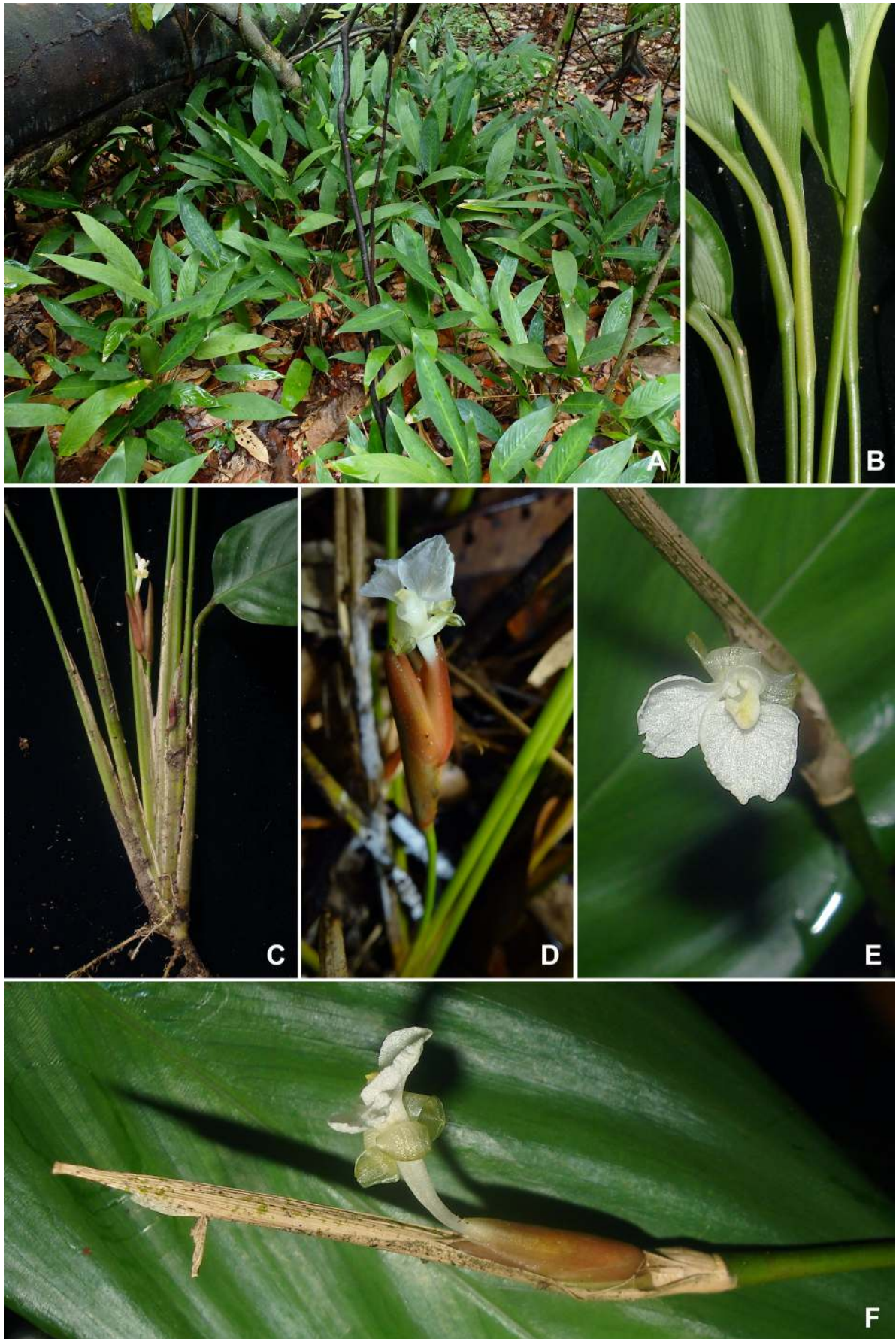


FIGURE 4. *Stachyphrynium parvum*. A. Habit. B. Detail of leaf blade bases showing pulvini. C. Base of plant with an inflorescence. D. Detail of inflorescence and flower. E. Detail of flower (front view). F. Detail of flower (side view). Based on *SNG-189*. (Photos: Jana Leong-Škorníčková)

Rhizomatous, rosulate terrestrial herb 0.3–0.6(–0.9) m, forming large clumps. Rhizome creeping, with shoots distanced 1.5–3.5 cm. Leaves 1–4 per shoot (sometimes also with an additional laminate bract that acts as the lowest bract in the inflorescence); sheath 9–19 cm, green when young, soon drying to pale yellow-brown and later papery, light brown, tomentose; petiole 12–42 cm, medium green, glabrous; pulvinus 2–4 cm; lamina narrowly ovate to narrowly elliptic, 16–27 × 4–6 cm, apex attenuate, base shortly attenuate, upper leaf surface dark green, glabrous (including midrib), lower surface light green, glabrous, except the midrib which is puberulous. Inflorescence terminal, peduncle 10–21 cm (but sometimes the lowest bract replaced by a laminate leaf, in practice making the ‘peduncle’ a leafy shoot), erect (extending a further 1–8 cm after the lowest bract/stalked laminate leaf), glabrous, green to light brown; bract at the base of the synflorescence narrowly elliptic, 3.2–4.5 × 0.8–1.2 cm or replaced by a small leaf; synflorescence spiciform (almost capitate when heavily branched), alternate and distichous, 3.2–4.5 cm; first order branches 1–3, branches erect (sometimes spreading) distichous, 2.5–3.5 cm (measured from base to the tips of bracts), usually simple (order of branches no greater than two), fertile bracts 1–4 per branch, alternate and distichous, curled on sides (appears tubular), narrowly elliptic when opened, with acute apex, 1.7–2.5 × 5–7 mm, (green to) red-brown, hirtellous with very short glandular hairs and a few longer hairs near margins (hairs never flocculose, see notes below); flower pairs two per special paraclade, associated prophylls narrowly elliptic, glabrous, 15 × 5 mm, with two distinct keels along the entire length on the abaxial surface, with acute apex, interphyll, narrowly elliptic, glabrous, colour not recorded, 7 × 3.5 mm; flower pair sessile, but each flower with a 1.5 mm pedicel, bracteoles absent. Flower ca. 2.1 cm, fragrance unknown; sepals 3, free, subulate, 4.5–5.0 × 0.3–0.5 mm, colour not observed; floral tube 15 mm, incompletely fused for the upper 2 mm; petal lobes elliptic, obtuse, 5.5 × 2–3 mm, semi-translucent pale yellow-green, slightly darker towards the apex, reflexed; staminodial tube absent, but some of the staminodes fused to 0.5–1.0 mm beyond floral tube; outer staminodes 2, unequal, spatulate, apparently crumpled in bud (folding still visible in open staminodes), white, larger with a free part of 5.2–5.5 × 3.9–4.1 mm, smaller with a free part of ca. 4.5 × 3.5 mm; hooded staminode cucullate, entire, white, with a free part of 3.2 × 2 mm, without an obvious appendix (a simple notch ca. 0.5 mm can be seen on the side of the staminode); fleshy staminode curved towards the pistil at sides, roughly semi-circular in cross-section, more or less linear but with a very abrupt, blunt end, white, the free part 2.4 × 2 mm (but fused to the fertile staminode in the lowest 0.7 mm), with a white appendix on one side, increasingly protruding from the staminode towards the apex, ca. 1.2 × 0.3 mm; fertile stamen (including the fertile anther and appendage) white with a yellow apex, 3.1 × 1.5 mm, anther emerging at 1.2 mm, 1.5 × 0.5 mm; style with a 3.1 mm free part, enrolled like a crozier, with a trumpet-like opening facing down, collapsed on one side to give an appearance of a mouth-like opening with lower and upper ‘lip-like’ extensions. The upper ‘lip’ yellow with small hairy black calli, stigmatic cavity ca. 0.5 mm diameter; ovary 1.2 mm, hirsute. Fruits not collected.

Provisional IUCN conservation assessment:—Endangered (EN, category B1ab(iii)B2ab(iii)). EOO 1,005 km², AOO 24 km², measured using an online tool at <http://geocat.kew.org>. As circumscribed here, *S. parvum* is restricted to a small area in Singapore (two populations known) and adjacent Peninsular Malaysia. Based on revision of herbarium material, only one location is known from Johor (*R.S. Holttum SFN 10294*, SING!). It is only known from primary forests, which have been largely lost in Johor and Singapore.

The population in Singapore appears stable, but is very small. The species appears superficially abundant along small areas, but most individuals here seem to form clonal clumps and it is certain they represent fewer than 50 genetically distinct mature individuals. It is considered Critically Endangered (CR) under category D.

Singapore specimens examined:—SINGAPORE. **MacRitchie:** Reservoir Jungle, 26 October 1944, *E.J.H. Corner s.n.* (SING); MacRitchie Reservoir, South side, 25 June 1949, *J. Sinclair s.n.* (L); MacRitchie Reservoir, 3 November 2009, *A.T. Gwee SING 2009-442* (SING); MacRitchie Reservoir, MR5, 18 February 2011, *J. Leong-Škorničková et al. SNG-52* (SING) (two sheets and spirit material) (SING); Lornie Trail, 14 August 2014, *J. Leong-Škorničková et al., SNG-189* (SING). **Without precise location:** Cluster 19, 11 May 1993, *W.S. Chee 1802* (SING, SINU).

Notes:—Ridley described *Stachyphrynium parvum* from material collected in forest surrounding MacRitchie Reservoir, which remains the only locality for this species in Singapore. It belongs to a species complex that includes three other validly published names, *Stachyphrynium sumatranum* (Miquel 1860: 616) Schumann (1902: 48) and *Stachyphrynium borneense* Ridley (1937: 204) and *Stachyphrynium calcicola* Poulsen & Clausager (2004: 162). The described names only cover some of the diversity known from this complex and the group is in dire need of taxonomic revision. The plants in Singapore and at least one collection from Malaysia (north of Gunung Belumat [Johor], 22 May 1923, *R.S. Holttum SFN 10294*, SING!), are distinct in having a very long pulvinus (2–4 cm), secondary veins at an acute, ca. 30° angle at the middle of the leaf blade, and in having rather elongate, attenuate leaf-tips. The other two species described have a short pulvinus (0.9–1.5 cm), secondary veins at broader angle (> 50°) and acuminate leaf-tips

(leaf tips are poorly visible due to curling in type material of *S. borneense*, but described as cuspidate-acuminate in the protologue). We are only aware of one collection from the main island of Sumatra (Loeboe Aloeng, not dated, 2037 HB, L!) and three more recent collections from offshore Sumatra in the Siberut Islands, not far from the type locality (Teiteibati National Reserve, Siberut Island, July 1992, *J.J. Afriastini 1911*, L!; Siberut, Sumatra, 26 February 2004, *A.D. Poulsen et al. 2256*, ANDA, BO, not seen; Siberut, Sumatra, 21 September 1924, *C. Boden-Kloss 14544*, SING!). We have not yet seen any duplicates of *A.D. Poulsen et al. 2256*, which was previously identified as *S. sumatranum*, but the other collections mentioned are very similar to each other. There appears to be some variability of the species in Peninsular Malaysia, with some collections appearing similar to *S. sumatranum* in leaf details (e.g. Sungei Semagot Kanan, 30th mile Kota Tinggi-Mersing Road, 6 October 1963, *J. Sinclair 10753*, SING!) and some observed in the field probably represent new taxa (JL-S, pers. obs.). Material of *Stachyphrynium* cf. *sumatranum* from Borneo are highly variable in terms of inflorescence length, bract shape and arrangement, and the indumentum which in some Bornean collections is clearly flocculose. We have not seen any material from Borneo that would be a good match for *S. parvum* in vegetative characters.

Although many specimens in this complex are now determined as *S. sumatranum* in various herbaria, including almost all specimens at SING, the synonymy has never been formally proposed in any publication. For the morphological reasons we have outlined above and our preliminary molecular evidence discussed below, we refrain from synonymising *S. parvum* with *S. sumatranum* (the latter having nomenclatural priority in this complex). We are of the opinion, that any synonymy in this complex should be based on comparison of living flowering material supplemented by DNA studies from across the entire distributional range of this complex as many important characters, particularly flower details, are lost in dried herbarium material. The yellow-green corolla lobes observed in Singapore material has not been reported elsewhere, but it is unclear if this is due to incomplete descriptions from those regions.

Molecular analysis

We sequenced two DNA regions (ITS1 and *rps16*) of *S. parvum* (GenBank accessions: ITS1= KX588491, *rps16* intron= KX588492) and we compared the results to four previously barcoded samples in the *S. sumatranum*-clade (Suksathan *et al.* 2009). We constructed parsimony and neighbour joining trees with all samples of *Stachyphrynium* Schumann (1902: 45) and using *Schumannianthus benthamianus* and *Halopegia blumei* (Schumann 1902: 51) as an outgroup. Pairwise sequence similarity between combined datasets were read in Geneious. The barcoded sequences of *S. parvum* have a 96 % similarity to both samples of *S. sumatranum*; the two available barcodes of *S. sumatranum*, though distant geographically (one from Siberut, Sumatra [*A.D. Poulsen et al. 2256*,], the other from Tawau Hills, Borneo [*S. Johanssen 10*, AAU!]), agree with each other closely (99 %). There were only 16 parsimony-informative characters in the two regions in this clade, including gap data, but *S. parvum* always paired with an identified sample from Borneo (*A.D. Poulsen et al. 2301*, specimen not seen), with which it had 97% sequence similarity. There was also a higher sequence similarity to *S. calcicola* than to samples of *S. sumatranum*. The available molecular evidence so far does not support sinking *S. parvum* into *S. sumatranum*.

Other significant Marantaceae in Singapore nature reserves

5. *Phrynium villosulum* Miq.

Phrynium villosulum was listed as a native, presumed nationally extinct species in the checklist of the flora of Singapore (Chong *et al.* 2009). We rediscovered this species along Taban Loop in Bukit Timah in spring 2015. However, a closer investigation of herbarium material at SING revealed that this species has only been collected at this same locality and only once in 1953 (Valley below Taban Circle, Bukit Timah, 6 October 1953, *J. Sinclair, S.F. 40040*). The collection has a note that reads: “probably planted by Corner”. This is in agreement with previous notes on species in Taban Loop. Leong-Škorničková & Boyce (2015) commented that there are several species in this area that are not otherwise native to Singapore, or areas nearby, but that correlate with regional collections by E.J.H. Corner. The living material was likely brought back by Corner’s field assistants Kiah and Md. Nur, who planted them on Bukit Timah, but when this was done remains unclear (Leong-Škorničková & Boyce 2015). The only patch of *P. villosulum* we have seen shows no evidence of sexual regeneration and is morphologically an exact match to the two collections by E.J.H. Corner in

1936 from Gunung Panti, Johor, Peninsular Malaysia (*S.F. 30957* and *S.F. 30680*). Based on this evidence, we consider this population to be introduced.



FIGURE 5. *Phrynium villosulum*. A. Habit. B. Detail of inflorescence and flower. C. Leaf blades showing the typical ornamentation of this species. Based on *SNG-326* (A–B) and an ornamental planting at Singapore Botanic Gardens (C). (Photos: Matti Niissalo-A & B; Jana Leong-Škorničková-C)

Phrynium villosulum is one of the most distinctive and attractive Southeast Asian Marantaceae with long petioles, giving the plant a height of 1.7–2.0 m. Each stem has 3 or 4 leaves, each with a lamina of 37–42 × 15–17 cm. The leaf blades are medium green and have 11–13 very dark green stripes that follow the secondary venation. The leaves are light green underneath, but the venation is also slightly visible on the lower surface. The inflorescence is placed

unusually low on the stem for a *Phrynium*, emerging at ground level from the base of the leaves (2–3 cm above the rhizome) through the leaf sheaths. The inflorescence is caespitose, growing at a 45° angle. The flowers, opening 1–4 at a time, are small (ca. 1 cm across), with dull pink, slightly transparent petals and white staminodes.

6. *Phrynium* sp.

There is a small population of a second *Phrynium* sp. along Taban Loop. We have not seen fresh flowers on the plant, only a single old inflorescence (JL-S, personal observation). We have been unable to identify the species and we strongly suspect that it is an undescribed species of *Phrynium*. We investigated the position of the samples in *Phrynium* sensu Suksathan *et al.* (2009) by sequencing two entire DNA regions (GenBank accessions: ITS1= KX588493, *rps16* intron= KX588494) and by conducting similar analysis as done for *Stachyphrynium parvum* using all sequences available in GenBank. We failed to match it closely with any other species in the genus and were unable to get a well-supported structure to elucidate the position of this species. Only in neighbourhood joining using ITS1 it came out as a sister to *Phrynium tristachyum* Ridley (1924: 290), a similar but much more robust species.

Superficially, this species is similar to *Phrynium venustum* Turner (1998: 39), but differs by having larger and plain green leaves, which are completely glabrous including the sides of the midrib (*P. venustum* instead has hairs at the sides of the midrib and pale stripes on the upper surface of the leaf). There is one collection at SING, currently filed under *Phrynium tristachyum* (E.J.H. Corner, S.F.N. 30397) from Terengganu, Peninsular Malaysia that apparently represents an undescribed species and is morphologically very similar to the Singaporean plant. The collection was discussed in some detail by Holttum (1951). A second unidentified collection from Sarawak (Hewitt 24) may also represent the same species. We were unable to acquire any DNA sequences from these herbarium specimens, but we suspect that the specimen Corner 30397 might be the best match to our species, especially as it was collected by Corner in the mid-1930's and therefore fits the origin of several other introduced species in Taban Loop. In absence of any other evidence, we consider this species introduced. The species has an appearance of a large clone of *Stachyphrynium parvum* with green 14–17 cm long petioles and a lamina of 25–28 × 8 cm. The inflorescence is small, protected by a leaf-sheath similarly to that described above for *Phrynium hirtum*.

7. *Schumannianthus benthamianus* (Kuntze 1892: 684) Veldkamp & Turner (2016: 47)

Schumannianthus benthamianus, is included in Singapore's *Checklist of Vascular Plants* (Chong *et al.* 2009) and in the national *Red List* (Davison *et al.* 2008), where it is listed as nationally Critically Endangered. As there is no specimen of this species at any herbaria we have examined, the above assessment remains puzzling. The first mention of this species in Singapore appears to be in the *Concise Flora of Singapore* (Keng *et al.* 1998), which does not cite any specimens. While there were two specimens of *Donax canniformis* from Pulau Ubin at SING mistakenly determined as *S. benthamianus*, both of these post-date the *Checklist* and the *Red List*. The species was reported in 2006 in an online checklist of plants at Pulau Ubin (published by National Parks Board Singapore, but the checklist is no longer available), probably based on the same misidentified population of *Donax* (data not supported by specimens). We suspect these misidentified specimens may be the reason it was included in the *Red List*. Although this species is widespread in the Malesian region, with the absence of any specimen (or existence of living population seen and confirmed by us) from Singapore, we consider this species not native to Singapore. The species is sold in local nurseries and is sometimes planted in Singapore near water features in parks or even in close proximity to nature reserves for its attractive, large, white flowers. The species is similar in appearance to *D. canniformis*, but differs from it by the larger flowers (ca. 3.5 cm), less branched and erect inflorescences, smaller leaves (length less than 15 cm) and glabrous midrib on the lower side of the leaf blades.

The species has until recently been universally referred to as *S. dichotomus*, which was recently shown to be invalid since its original circumscription included the earlier *Donax canniformis* (Veldkamp & Turner, 2016).

8. *Thaumatococcus daniellii* (Bennett 1855: 161) Benth (1883: 652)

Thaumatococcus daniellii is the only non-native Marantaceae that has naturalised in Singapore. It can be seen along roads and forest margins, but only in areas that are heavily occupied by introduced species in general. The most clearly naturalised population is present near the carpark at Bukit Timah Nature Reserve, which is the only location where it has been seen flowering and fruiting.



FIGURE 6. *Schumannianthus benthamianus*. A. Habit. B. Detail of flowers. *Phrynium* sp. C. Habit. *Thaumtococcus daniellii*. D. Habit. E. Inflorescence and flowers. F. Fruits. (Photos: Jana Leong-Škorničková)

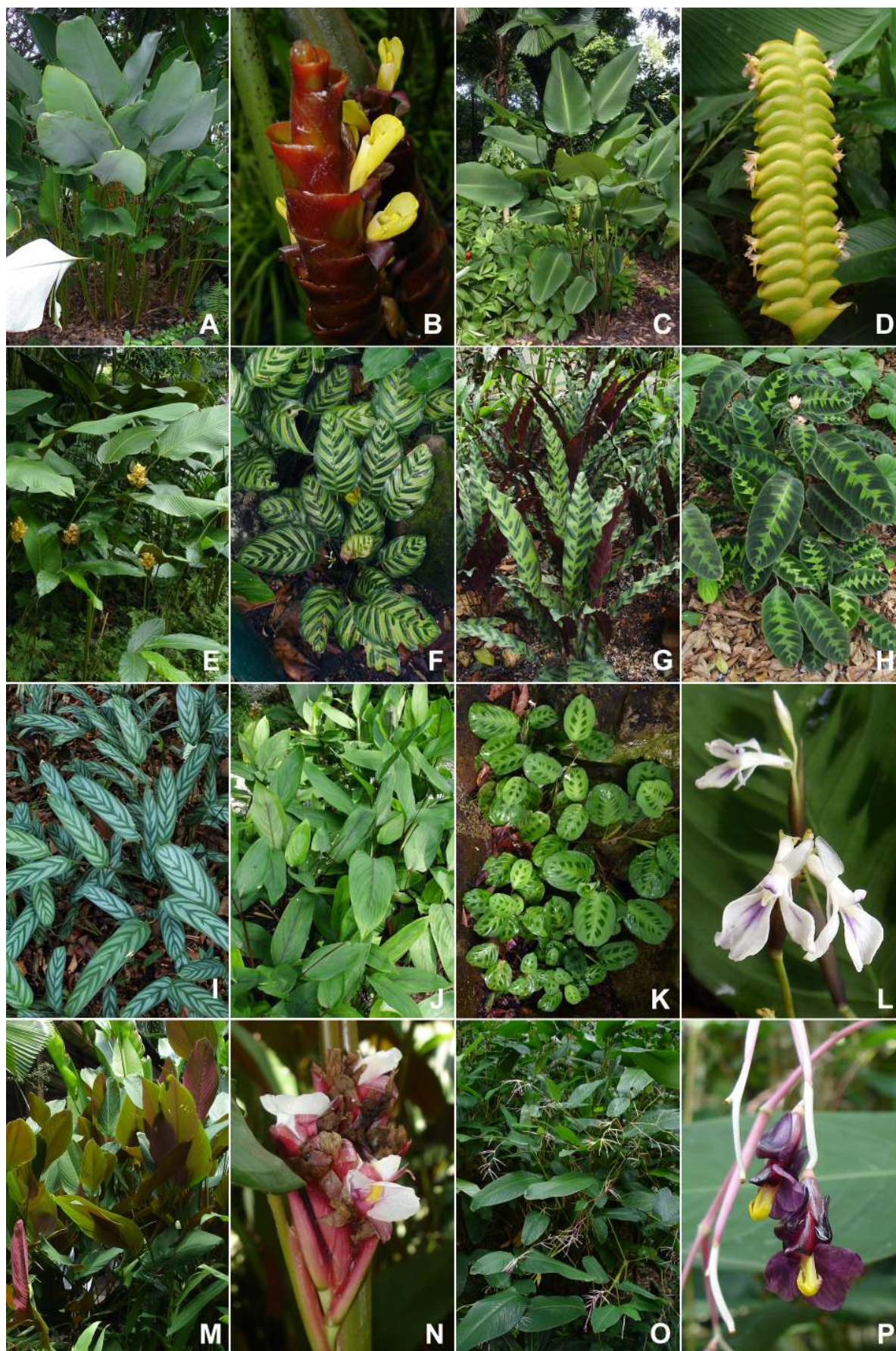


FIGURE 7. Cultivated species. A–B. *Calathea lutea*. C–D. *Calathea crotalifera*. E. *Goeppertia majestica*. F. *Goeppertia makoyana*. G. *Goeppertia undulata*. H. *Goeppertia warszewiczii*. I. *Ctenanthe setosa*. J. *Maranta arundinacea*. K–L. *Maranta leuconeura*. M–N. *Marantochloa mannii*. O–P. *Marantochloa purpurea*. (Photos: Jana Leong-Škorníčková)



FIGURE 8. Cultivated species. A–B. *Pleiostachya pruinosa*. C. *Stachyphrynium repens*. D. *Stromanthe sanguinea* ‘Tricolor’. E–F. *Thalia dealbata*. G–H. *Thalia geniculata*. (Photos: Jana Leong-Škorničková)

The species originates from Western Africa, where it is well known as a vegetable, a leaf for food wrap, and a ‘miraculous fruit’ because the aril is extremely sweet (Leong-Škorničková 2013). Sterile plants are superficially similar to *Stachyphrynium latifolium*, but the leaves of *Thaumatococcus* are dark glossy green above and lack the waxy glaucous lower leaf surface. The leaf margin is not distinctively coloured. The pale purple flowers are on a radical shoot, protected by large, deciduous bracts. The bright red fruits are large, triangular and presented on soil surface.

Key to Singapore Marantaceae

1. Plants rosulate only with a short (<1 m) simple stem that supports an inflorescence; Leaves generally basal, at most a single laminate leaf on a prominent stem, always associated with an inflorescence2.
1. Shrubs with a tall (>1.5 m) aerial stem with several orders of branching and many leaves; all leaves on prominent stems7.
2. Large plant with leaves over 1 m tall3.
2. Small plant to 0.9 m tall, including leaves, usually shorter.....6.
3. Synflorescence terminal on a leafy stem.....4.
3. Synflorescence radical, on a stem protected by several bract-like scales5.
4. Leaves green, with a pink shine on the abaxial surface when young; on flowering plants the uppermost leaf on top of a prominent stem (60–70 cm), inflorescence emerging from the base of the uppermost leaf..... *Phrynium hirtum*
4. Leaves green with prominent dark green striation; inflorescence emerging through the leaf-sheaths at 3–4 cm height..... *Phrynium villosulum*
5. Underside of leaves with a distinctly coloured band on one margin; inflorescences with persistent yellow-green bracts and small (2 cm) white flowers..... *Stachyphrynium latifolium*
5. Underside of leaves uniform in colour; inflorescence with large deciduous pink bracts and small (2 cm) pale purple flowers..... *Thaumatococcus daniellii*
6. Leaves 16–27 cm; with a prominent terminal, leafless inflorescence (but rarely similar in inflorescence structure to the next species)..... *Stachyphrynium parvum*
6. Leaves 26–28 cm; on flowering plants the uppermost leaf on top of a prominent stem, inflorescence emerging from the base of the

- | | | |
|----|---|-------------------------------------|
| | uppermost leaf | <i>Phrynium</i> sp. |
| 7. | Leaves (16–)23–27 cm; inflorescence variable, but usually pendulous and often heavily branched, flower 1.7–1.9 cm | <i>Donax canniformis</i> |
| 7. | Leaves 8–14 cm; inflorescence upright, rarely branched, flower ca. 3.5 cm | <i>Schumannianthus benthamianus</i> |

Commonly cultivated Marantaceae in Singapore

The checklist of Singapore's flora (Chong *et al.* 2009) lists 27 cultivated species of Marantaceae belonging to six genera. Further cultivated species are listed in Leong-Škorničková & Gallick (2010) and Boo *et al.* (2003). Even more are present in the horticultural trade, private collections and the two botanical gardens in Singapore. Indeed, exotic Marantaceae are an integral part of the greenery employed in the parks, streetscapes or private gardens. The most common genera and species encountered in Singapore's parks and streetscapes are briefly discussed below.

Calathea Meyer (1818: 6), tropical Americas

Once the largest genus in the family, *Calathea* now has only 37 species. Two are in general cultivation in Singapore. In Singapore the genus can be identified by the large leaf lamina on a tall stalk, often higher than 2 m, similar to *Thaumatococcus daniellii* but with a grey waxy surface on the leaves. The flowers are in a flattened, yellow synflorescence. By far the most commonly cultivated species is *C. lutea* (Aublet 1775: 4) Schultes (1822: 8) (fig. 7A–B). It has been widely planted in traffic dividers, shopping malls and private gardens for its large leaves. Less commonly cultivated *C. crotalifera* Watson (1889: 86) has larger, brighter yellow synflorescences (fig. 7C–D).

Ctenanthe Eichler (1884: 83), tropical Americas

Ctenanthe is a South American genus with variegated leaves, superficially very similar to *Goeppertia* and used similarly as ornamentals in gardens. The two genera are easiest told apart by the fashion the leaves unfold: in *Ctenanthe* each leaf curls open in the opposite direction to the previous leaf (antitropic), whereas in *Goeppertia* (and *Calathea*) the direction of curling is constant (homotropic) (Andersson 1981). There are 15 species in *Ctenanthe*, of which *C. lubbersiana* (Morren 1882: 21) Eichl. in Petersen (1890: 159), *C. oppenheimiana* (Morren 1875: 271) Schumann (1902: 155) and *C. setosa* Eichler (1884: 84) (fig. 7I) are cultivated in Singapore.

Goeppertia Nees (1831: 337), tropical Americas

Most species previously included in *Calathea* have been recently moved to *Goeppertia*, which became the largest genus in Marantaceae with 250 species (Borchsenius *et al.* 2012). Most of these species have strongly variegated leaves and a cone-shaped, colourful synflorescence. Too many species are in cultivation in Singapore to give a comprehensive list and species in this genus can be seen planted in gardens and indoors for their attractive, variegated foliage (fig. 7E–H). *Goeppertia majestica* (Linde 1865: 103) Borchs. & S. Suárez in Borchsenius *et al.* (2012: 632) (fig. 7E) is popular due to its attractive, often white-veined leaves. It has been planted in the vicinity of the Bukit Timah Nature Reserve.

Maranta Linnaeus (1753a: 2), tropical Americas

Maranta is one of the largest genera in Marantaceae with ca. 50 species. The genus is easiest to identify by synflorescence characteristics: their bracts are quite inconspicuous, lax, green, and supporting clearly separated flower-pairs. The most commonly cultivated species in Singapore is *M. arundinacea* Linnaeus (1753a: 2) (arrow-root, fig. 7J), seen in communal gardens as an ornamental. Other cultivated species (*M. leuconeura* Morren [1874: 323] in particular, fig. 7K–L) are small plants with distinctly mottled leaves, used as ground cover.

Marantochloa Gris (1860: 321), Africa

Marantochloa is superficially similar to native *Donax* and *Schumannianthus* in their tall, branched aerial stems and similar inflorescence structures. *Marantochloa* are usually smaller, and the flowers in commonly cultivated species are either dark wine-red on a sparse inflorescence (*M. purpurea* [Ridley, 1887: 132] Milne-Redh. in Léonard & Milne-Redhead [1950: 21], fig. 7O–P), paler purple in a tighter, spiciform inflorescence (*M. mannii* (Bentham 1883: 653) Milne-Redhead [1952: 167], fig. 7M–N) or greenish white (*M. leucantha* (Schuman 1892: 436) Milne-Redh. in Léonard & Milne-Redhead [1950: 19]).

***Pleiostachya pruinosa* (Regel 1878: 104) Schumann (1902: 165), Central America**

Pleiostachya pruinosa (fig. 8A–B) is planted in Singapore for its attractive large foliage with strongly coloured, purple-red abaxial leaf surfaces. The flowers appear in clustered, spiciform inflorescences.

***Stachyphrynium repens* (Körnigke 1862: 103) K.Schum., continental tropical Asia**

This small species can be found planted in Singapore as a ground cover in shaded areas. It bears superficial similarity to *Stachyphrynium parvum*, but has distinct striation of the leaves, not unlike the much larger *Phrynium villosulum*. Fig. 8C.

***Stromanthe sanguinea* Sonder (1849: 225), tropical Americas**

This species has short aerial stems and long leaves that are strongly purple on the abaxial surface. Cultivar *S. s.* ‘Tricolor’ (fig. 8D) with variegated green-white-red foliage is popular. The heavily branched, pink-red inflorescences are held high above the leaves, but in Singapore’s tropical climate flowering occurs only very rarely.

***Thalia* Linnaeus (1753b: 1193), Africa and tropical Americas**

Two species of the amphibious *Thalia* L. are commonly planted along waterways and in water features in gardens in Singapore for their tall, upright leaves and attractive flowers. *Thalia geniculata* Linnaeus (1753b: 1193) has lax, drooping synflorescences (fig. 8G–H) with a distinct zig-zag pattern, whereas *T. dealbata* Roscoe (1807: 340) (fig. 8E–F) has compact synflorescences with several cone-like branches.

Typification of non-native Marantaceae discussed

The lectotype of *Phrynium sumatranum* is here designated to clarify the nomenclature in a poorly understood species complex within genus *Stachyphrynium*. We are only aware of a single sheet that corresponds to the type collection; the location details match with those mentioned by Miquel, and even though there is no mention of the collector on the sheet, the label is very similar to other collections of Teijsmann from Sumatra, with the same handwriting. Since it was placed in Utrecht (U) before being moved to Naturalis (L), it is almost certainly the specimen that Miquel based his description on (Steenis-Kruseman 2014). There may be further specimens at BO.

***Stachyphrynium sumatranum* (Miq.) Schumann (1902: 48)**

Basionym:—*Phrynium sumatranum* Miquel (1860: 616).

Type:—INDONESIA. Loeboe Aloeng [Lubuk Alung, Padang, Sumatra, ca. 0°40’40’’S 100°18’50’’E], not dated [probably 20–21 November 1855], 2037 HB [probably J.E. Teijsmann] (lectotype L! [U0124090], **here designated**).

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References

- Almeida, M.R. (2009) *Flora of Maharashtra, volume 5a*. Orient Press, Mumbai, 245 pp.
- Andersson, L. (1981) The neotropical genera of Marantaceae. Circumscription and relationships. *Nordic Journal of Botany* 1: 218–245.
<http://dx.doi.org/10.1111/j.1756-1051.1981.tb00692.x>
- Andersson, L. (1998) Marantaceae. In: Kubitzki, K. (Ed.) *The families and genera of vascular plants, Vol. 4. Flowering plants, monocotyledons: Alismatanae and Commelinanae (except Gramineae)*. Springer-Verlag, Berlin, Germany. pp. 278–293.
- Andersson, L. & Chase, M.W. (2001) Phylogeny and classification of Marantaceae. *Botanical Journal of the Linnean Society* 135: 275–287.
<http://dx.doi.org/10.1006/bojl.2000.0418>
- Ardiyani, M., Poulsen, A.D., Suksathan, P. & Borchsenius, F. (2010) Marantaceae in Sulawesi. *Reinwardtia* 13: 213–220.
- Aublet, J.B.C.F. (1775) *Histoire des Plantes de la Guiane Française*. P.-F. Didot jr, Paris, 621 pp.
- Baker, J.G. (1892) Order CXLIX. Scitamineae. In: Hooker, J.D. (Ed.) *The Flora of British India, volume 6*. L. Reeve & Co, London, pp. 198–264.
- Beentje, H. (2010) *The Kew Plant Glossary, an illustrated dictionary of plant terms*. Royal Botanic Gardens, Kew, Richmond, Surrey, 164 pp.
- Bennett, J.J. (1855) Description of a new species of *Phrynium* from Western Africa. *The Pharmaceutical Journal and Transactions* 14: 161.
- Bentham, G. (1883) Ordo CLXX. Scitamineae. In Bentham, G. & Hooker J.D. *Genera plantarum ad exemplaria imprimis in herbariis kewensibus, volume 3 part 2*. L Reeve & Co, London, pp. 636–657.
- Blanco, F.M. (1837). *Flora de Filipinas*. D. Miquel Sanchez, Manila, 619 pp.
- Blume, C.V. (1827) *Enumeratio plantarum Javae et insularum adjacentium*. J.W. van Leeuwen, Leiden, 274 pp.
- Boo, C.M., Omar-Hor, K. & Ou-Yang, C.L. (2003) *1001 garden plants in Singapore*. National Parks Board, Singapore, 489 pp.
- Boo, C.M., Chew, S.Y.J. & Yong, J.W.H. (2014) *Plants in tropical cities*. Self-published, 990 pp.
- Borchsenius, F., Suárez, L.S.S. & Prince, L.M. (2012) Molecular phylogeny and redefined generic limits of *Calathea* (Marantaceae). *Systematic Botany* 37: 620–635.
<http://dx.doi.org/10.1600/036364412X648571>
- 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*. National University of Singapore, Singapore, 273 pp. Available from: http://lknhm.nus.edu.sg/nus/pdf/PuBliCatIoN/IKCNh%20Museum%20Books/IKCNhM%20Books/flora_of_singapore_tc.pdf (accessed 7 July 2014)
- Christenhusz, M.J.M. & Byng, J.W. (2016) The number of known plants species in the world and its annual increase. *Phytotaxa* 261 (3): 201–217.
<http://dx.doi.org/10.11646/phytotaxa.261.3.1>
- Clarke, C.B. (1883) Cyrtandreae. In: Candolle, A.L.P.P. de & Candolle, A.C.P. de (Eds.) *Monographiae phanerogamarum* 5. G. Masson, Paris, 654 pp.
- Clarke, C.B. (1908) Materials for a flora of the Malayan Peninsula. *Journal of the Asiatic Society of Bengal* 74: 627–908.
- Clausager, K. & Borchsenius, F. (2003) The Marantaceae of Sabah, Northern Borneo. *Kew Bulletin* 58: 647–678.
- Davison, G.W.H., Ng, P.K.L. & Ho, H.C.C. (Eds.) (2008) *The Singapore red data book: threatened plants and animals of Singapore, 2nd Edition*. The Nature Society, Singapore, 285 pp.
- Dietrich, A. (1831). *Species plantarum*. ed. 6. Vol. 1. Nauck, Berlin, 735 pp.
- Eichler, A.W. (1884) Beiträge zur Morphologie und Systematik der Marantaceen. *Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin* 1883: 1–99.
- Forster, G. (1786) *Florulae insularum Australium prodromus*. J.C. Dietrich, Göttingen, pp. 1–103.
- Gagnepain, F. (1904) Zingibéracées et Marantacées nouvelles de l’herbier du muséum (12^e note). *Bulletin de la Société Botanique de France* 51: 164–182.
- Griffith, W. (1851) *Notulae ad plantas Asiaticas, part 3*. C.E. Serrao, Calcutta, 436 pp.
- Gris, J.A.A. (1860) Note sur une plante qui constitué probablement un nouveau genre de la tribu des Marantées. *Bulletin de la Société Botanique de France* 7: 320–323.
- Holtum, R.E. (1951, “1950”) The Marantaceae of Malaya. *Gardens’ Bulletin Singapore* 14: 254–296.

- Kearse, M., Moir, R., Wilson, A., Stones-Havas, S., Cheung, M., Sturrock, S., Buxton, S., Cooper, A., Markowitz, S., Duran, C., Thierer, T., Ashton, B., Mentjies, P. & Drummond, A. (2012) Geneious Basic: an integrated and extendable desktop software platform for the organization and analysis of sequence data. *Bioinformatics* 28: 1647–1649.
<http://dx.doi.org/10.1093/bioinformatics/bts199>
- Kennedy, H. (2000) Diversification in the pollination mechanisms in Marantaceae. In: Wilson, K.L. & Morrison, D.A. (Eds.) *Monocots: systematics and evolution*. CSIRO, Collingwood, pp. 335–343.
- Kiew, R. & Lim, C.L. (2011) Names and new combinations for Peninsular Malaysian species of *Codonoboea* Ridl. (Gesneriaceae). *Gardens' Bulletin Singapore* 62: 253–276.
- Körnigke, F.A. (1858) Beiträge zur Kenntniss der in unsern Gärten cultivirten Maranteen. In: Regel, E. (Ed.) *Gartenflora*, Bd. 7. Verlag von F. Enke, Erlange, pp. 66–89.
- Körnigke, F.A. (1862) Monographiae marantearum prodromus. *Bulletin de la Société Impériale des Naturalistes de Moscou* 35: 1–147.
- Kuntze, C.E.O. (1891) *Revisio generum plantarum, pars 2*. A. Felix, Leipzig, 1011 pp.
- Léonard, J. & Milne-Redhead, E. (1950) Clef pratique des Marantacées Congolaises. *Bulletin de la Société Botanique de Belgique* 83: 5–32.
- Leong-Škorničková, J. & Gallick, D. (2010) *The Ginger Garden, Singapore Botanic Gardens pictorial pocket guide 2*. National Parks Board, Singapore, 177 pp.
- Leong-Škorničková, J. (2013) *Thaumatococcus*: nature's sweetest secret. *Gardenwise* 40: 27–28.
- Leong-Škorničková, J. & Boyce, P.C. (2015) *Hanguana* in Singapore demystified: an overview with description of three new species and a new record. *Gardens' Bulletin Singapore* 67: 1–28.
<http://dx.doi.org/10.3850/S2382581215000010>
- 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. *Gardens' Bulletin Singapore* 66: 153–167.
- Ley, A.C. & Claßen-Bockhoff, R. (2011) Ontogenic and phylogenetic diversification in Marantaceae. In: Wanntorp, L. & Ronse de Craene, L.P. (Eds.) *Flowers on the tree of life*. Cambridge University Press, Cambridge, pp. 236–255.
- Linde, J.J. (1865) Introductions nouvelles de M.J. Linden, a Bruxelles. *Belgique Horticole* 15: 98–104.
- Linnaeus, C. (1753a) *Species plantarum, tomus 1*. L. Salvius, Stockholm, 560 pp.
- Linnaeus, C. (1753b) *Species plantarum, tomus 2*. L. Salvius, Stockholm, pp. 561–1200.
- Loureiro, J. de (1790) *Flora Cochinchinensis 1*. Ulyssipone, Lisbon, 353 pp.
- Malaysian National Biodiversity Clearing House Mechanism (2016) *Flora Database*. Online database. Available from: <http://www.chm.frim.gov.my/Bio-Diversity-Databases/Flora-Database.aspx> (accessed 26 February 2016)
- Merrill, E.D. (1918) *Species Blancoanae*. Bureau of Printing, Manila, 423 pp.
- Merrill, E.D. (1922) New or noteworthy Bornean plants. *Journal of the Straits Branch of the Royal Asiatic Society* 85: 151–201.
- Meyer, G.F.W. (1818) *Primitiae florum Essequiboensis*. H. Dieterich, Göttingen, 316 pp.
- Miquel, F.A.W. (1860) *Flora van Nederlandsch Indië, eerste bijvoegsel*. Fried, Fleischer, Leipzig, C. van der Post, Jr, Utrecht & C.G. van der Post, Amsterdam, 656 pp.
- Milne-Redhead, E. (1952) Notes on African Marantaceae. *Kew Bulletin* 7: 167–170.
- Morren, C.J.E. (1874) Note sur le *Maranta leuconeura*. *Belgique Horticole* 24: 323–324.
- Morren, C.J.E. (1875) Nouvelles Marantacées du Brésil, à feuillage orné et coloré. *Belgique Horticole* 25: 269–274.
- Morren, C.J.E. (1882) Note sur le *Stromanthe lubbersiana*, *Phrynium lubbersi* Hort. Mak., famille des Cannacées. *Belgique Horticole* 32: 21–23.
- Nees, von E.C.G.D. (1831) Über die Gattungen *Maranta* und *Thalia*. *Linnaea* 6: 303–342.
- Nicolson, D.H. & Arculus, D. (2001) Candidates for neotypification of Blanco's names of Philippine plants: specimens in the U.S. National Herbarium. *Taxon* 50: 947–954.
- Niissalo, M.A., Wijedasa, L.S., 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: 14–20.
<http://dx.doi.org/10.11646/phytotaxa.188.1.2>
- Niissalo M.A., Leong-Škorničková J., Khew G.S. & Webb E.L. (in press) Very small relict populations suggest high extinction debt of gingers in primary forest fragments of a tropical city. *American Journal of Botany*.
- Petersen, O.G. (1890) Musaceae, Zingiberaceae, Cannaceae, Marantaceae. In: Martius, C.F.P. von & Eichler, A.G. (Eds.) *Flora Brasiliensis, volume 3 part 3*, F. Fleischer, Leipzig, pp. 1–172.
- Poulsen, A.D. & Clausager, K.W. (2004) A new species of *Stachyphrynium* (Marantaceae) from Borneo. *Gardens' Bulletin Singapore* 56: 161–166.
- Prince, L.M. & Kress, W.J. (2006a) Phylogenetic relationships and classification in Marantaceae: insights from plastid DNA sequence data. *Taxon* 55: 281–296.

- Prince, L.M. & Kress, W.J. (2006b) Phylogeny and biogeography of the prayer plant family: getting to the root problem in Marantaceae. *Aliso* 22: 645–659.
- Rafinesque, C.S. (1836) *Flora Telluriana, pars 4*. H. Probasco, Philadelphia, 135 pp.
- Rastogi, P.A. (2000) MacVector. Integrated sequence analysis for the Macintosh. *Bioinformatics Methods and Protocols* 132: 47–69.
- Regel, E. (1878) Übersicht der Arten der Gattungen *Maranta* und *Calathea* nach den vegetativen Organen. *Gartenflora* 27: 100–105.
- Retzcius, A.J. (1791) *Observationes botanicae*. S. Leurecht Crusium, Leipzig, parts I–VI (pagination not continuous).
- Ridley, H.N. (1887) Angolan Scitamineae. *Journal of Botany* 25: 129–135.
- Ridley, H.N. (1899) The Scitamineae of the Malay Peninsula. *Journal of the Straits Branch of the Royal Asiatic Society* 32: 85–184.
- Ridley, H.N. (1907) *Materials for a Flora of the Malayan Peninsula, part 2*. Methodist Publishing House, Singapore, 235 pp.
- Ridley, H.N. (1910) New or rare Malayan plants, series V. *Journal of the Straits Branch of the Royal Asiatic Society* 54: 1–62.
- Ridley, H.N. (1924) The flora of the Malay Peninsula 4: Monocotyledons. L. Reeve & Co., London, 383 pp.
- Ridley, H.N. (1937) New Asiatic Scitamineae. *Journal of Botany, British and Foreign* 75: 202–205.
- Rolfe, A. (1907) *Donax* and *Schumannianthus*. *Journal of Botany, British and Foreign* 45: 242–244.
- Roscoe, W. (1807) XIX. New arrangement of the plants of the Monandrian class usually called Scitamineae. *Transactions of the Linnean Society* 8: 330–357.
- Roscoe, W. (1828) *Monandrian plants of the order Scitamineae*. G. Smith, Liverpool, not paginated.
- Roxburgh, W. (1810) Descriptions of several of the monandrous plants of India, belonging to the natural order called Scitamineae by Linnaeus, Cannae by Jussieu, and Drimyrhizae by Ventenat. *Asiatic Researches* 11: 318–362.
- Roxburgh, W. (1820) *Flora Indica, or descriptions of Indian plants, volume 1*. Mission Press, Serampore, 493 pp.
- Salisbury, R.A. (1812) On the cultivation of rare plants. *Transactions of the Horticultural Society of London* 1: 261–366.
- Schultes, J.A. (1822) *Mantissa I*. J. G. Cottae, Stuttgart, 386 pp.
- Schumann, K. (1892, “1893”) Beiträge zur Flora von Afrika. III. Marantaceae africanae. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie* 15: 428–446.
- Schumann, K. (1897) Marantaceae. In: Engler, A. & Prantl, K. (Eds.) *Die Natürlichen Pflanzenfamilien, Nachträge zum 2–4*. W. Engelmann, Leipzig, pp. 94–96.
- Schumann, K. (1902) Marantaceae. In: Engler, A. (Ed.) *Das Pflanzenreich IV. 48. (Heft 11)*. W. Engelmann, Leipzig, pp. 1–184.
- Schrank, F. de P. (1824) *Sylloge plantarum novarum*. C.E. Brenck, Regensburg, 244 pp.
- Sonder, O.W. (1849) *Stromanthe* Sonder nov. gen. e famil. Mantacearum. *Neue Allgemeine Deutsche Garten-und Blumenzeitung* 5: 225–228.
- Steenis-Kruseman, M.J. van (2014) *Cyclopaedia of Malesian Collectors*. National Herbarium Netherland, Leiden. Available from: <http://www.nationaalherbarium.nl/fmcollectors/> (accessed 5 June 2016)
- Steudel, E.G. von (1840) *Nomenclator botanicus. editio secunda, volume 1–2*. E. G. Cottae, Stuttgart and Tübingen, 852 pp.
- Suksathan, P. & Borchsenius, F. (2003) Two new species of *Stachyphrynium* (Marantaceae) from SE Asia. *Willdenowia* 33: 403–408.
- Suksathan, P. & Borchsenius, F. (2005) Nomenclatural synopsis of Marantaceae in Thailand. *Taxon* 54: 1083–1090.
- Suksathan, P., Gustafsson, M.H. & Borschenius, F. (2009) Phylogeny and generic delimitation of Asian Marantaceae. *Botanical Journal of the Linnean Society* 159: 381–395.
<http://dx.doi.org/10.1111/j.1095-8339.2009.00949.x>
- Suksathan, P., Madulid, D.A. & Borchsenius, F. (2010) Marantaceae in the Philippines. *Taiwania* 55: 28–36
- The Plant List (2013) *The plant list, version 1.1*. Available online; <http://www.theplantlist.org/> (accessed 7 March 2016)
- Turner, I.M. (1998) Nomenclatural changes for four Malayan species in *Phrynium* (Marantaceae), *Solanum* (Solanaceae), *Stachyphrynium* (Marantaceae) and *Boesenbergia* (Zingiberaceae). *Gardens' Bulletin Singapore* 50: 39–41.
- Turner, I.M. (2000) The plant taxa of H.N. Ridley, 3. The Zingiberales. *Asian Journal of Tropical Biology* 4: 1–47.
- Veldkamp, J.F. (1989) XIV. A note on Philippine collections of F.M. Blanco and A. Llanos. *Flora Malesiana Bulletin* 10: 143–145.
- Veldkamp, J.F. & Turner, I.M. (2016) The correct name for *Schumannianthus dichotomus* (Marantaceae). *Kew Bulletin* 71: 47.
<http://dx.doi.org/10.1007/s12225-016-9660-7>
- Wagenitz, G. (not dated) History of the collection, the Frister Herbarium at Göttingen (GOET). Albrecht-von-Haller-Institut für Pflanzenwissenschaften, Göttingen. Available from: <https://www.uni-goettingen.de/de/history-of-the-collection/186900.html> (accessed 8 June 2016)
- Wallich, N. (1832) *A numerical list of dried specimens*. Unpublished catalogue, various paginations.
- Watson, S. (1889) Contributions to American botany. *Proceedings of the American Academy of Arts and Sciences* 24: 36–87.
- Willdenow, C.L. von (1797) *Species plantarum. edition quarta 1*. G. C. Nauk, Berlin, 495 pp.