

Notes on Singapore native Zingiberales I: A new species of *Zingiber* and notes on the identities of two further *Zingiber* taxa

J. Leong-Škorničková¹, A. Thame¹ & P.T. Chew²

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

²Conservation Division, Central Nature Reserve,
National Parks Board, 1 Cluny Road, Singapore 259569

ABSTRACT. A new species of *Zingiber singaporense* Škorničk., is described and illustrated here. It is compared to other species from the *Zingiber gracile* (*Zingiber* sect. *Zingiber*) alliance. A key to this group of species in Peninsular Malaysia and Singapore and a key to all Singapore native and naturalised *Zingiber* species are provided. The national and international conservation status of the new species and a conservation strategy for it are discussed. Notes on the varietal identity of *Zingiber puberulum* and the presence of *Z. ottensii*, previously misidentified as *Z. zerumbet*, in Singapore are given.

Keywords. Central Catchment Nature Reserve, conservation, IUCN, *Zingiber gracile*, *Z. griffithii*, *Z. ottensii*, *Z. puberulum*, *Z. singaporense*, *Z. zerumbet*, Zingiberaceae

Introduction

A conservation project on Singapore's native Zingiberales was initiated by the Research & Conservation Branch of the Singapore Botanic Gardens, National Parks Board, in January 2011. Although the initial 15 months of funding has expired, the project continues in various forms with support from a wide network of collaborators within and outside NParks. Initially, the project mainly involved intensive surveys of forested areas, marking of all existing populations/mature adult plants of native Zingiberales, regular monitoring of flowering and seed-set, and *ex situ* and *in vitro* propagation of native material from Singapore stock for re-introduction purposes. These efforts continue but, as we progress with the project, we are also realising that there is a need to clarify various taxonomic issues (correct identifications, nomenclature). We are also conducting in-depth studies of reproductive biology and are updating the IUCN conservation status for all native Zingiberales in Singapore. This paper is the first in the series entitled 'Notes on Singapore Native Zingiberales'. This series will include rediscoveries of taxa presumed to be extinct in Singapore, provide taxonomic and nomenclature updates, and raise awareness of, and encourage an active approach towards, the conservation of native Zingiberales and other plants in Singapore.

Information on Singapore's geography and vegetation types, and the affinities of its flora to those of Peninsular Malaysia and Sumatra, have recently been discussed in detail (e.g. Chong et al., 2011; Ng et al., 2011; Yee et al., 2011; Low et al., 2014) and are, therefore, not repeated here. Recently, as interest has increased, numerous surveys have reported new records for Singapore as well as rediscoveries of presumed locally extinct species (e.g. Rodda et al., 2012; Yeoh et al., 2013; Low et al., 2014). As Singapore's flora is comparatively well known, and forested areas with primary and mature secondary forests fairly small (accounting for about 3% - Yee et al., 2011), reports of a new plant taxon from Singapore are infrequent. A *Cryptocoryne* Fisch. ex Wydler hybrid from Bukit Timah Nature Reserve was reported in 2001 (Bastmeijer & Kiew, 2001). Nine new species of *Thottea* Rottb. were also described by Yao (2013) from Peninsular Malaysia, of which *T. praetermissa* T.L.Yao is also found in Singapore. The most recent example is of two *Utania* G.Don species (Gentianaceae) occurring in Singapore and the southern part of Peninsular Malaysia (Sugumaran & Wong, 2014), based on types from Singapore. The presence of the *Thottea* and the two *Utania* species were, however, already recorded in Singapore from the 1890s with multiple collections for all three taxa, albeit misidentified. In this paper, we present a new ginger species for which no earlier collections are known.

In 2012, two sterile living specimens of a small *Zingiber* Mill. species were collected during a regular survey in Singapore's Central Catchment Nature Reserve by William Ng of the National Parks Board, Singapore. Unfortunately, neither of the plants survived and the original collection locality, said to contain just a few individuals, could not be re-located. In October 2013 and April 2014, the same species was found in three different locations within patches of primary and mature secondary forest in the Central Catchment Nature Reserve. In May 2014, flowering plants were found at all three locations. These collections could not be matched to any *Zingiber* species from Singapore, Peninsular Malaysia, Borneo or Sumatra after careful study of type material, additional herbarium specimens and the protologues of all related species of *Zingiber* sect. *Zingiber* from the Malesian region by the first author. It was, therefore, concluded that these new collections belong to a taxon as yet unknown to science which we here name *Zingiber singaporense*. The description and measurements are made from living material from all three populations. As previous works by Holttum (1950) and Theilade (1998) were mainly based on herbarium specimens, the dimensions of certain parts from dried material are also given to allow direct comparison to their descriptions and to type material of related taxa.

Taxonomy

***Zingiber singaporense* Škorničk., sp. nov.**

Similar to *Zingiber aurantiacum* (Holttum) Theilade, but differing in the smaller and more slender habit, inflorescences with distinctly convex fertile bracts (versus tightly appressed bracts), reduced bracteoles (up to 6 mm long versus c. 25 mm long) and

lateral staminodes partly free from labellum (versus staminodes almost fully connate with labellum). TYPE: Singapore, Central Catchment Nature Reserve, MacRitchie sector, 7 May 2014, *J. Leong-Škorničková & Aung Thame SNG-178* (holotype SING (including spirit material); isotypes E, K, KEP). (Fig. 1, 2)

Perennial evergreen rhizomatous herb to 0.8 m tall. **Rhizome** 7–10 mm in diam., branched, internally light yellow, mildly aromatic. **Leafy shoots** of mature flowering individuals 0.7–1.5 m long, strongly arching, with 18–30 leaves; basal $\frac{1}{4}$ – $\frac{1}{5}$ leafless, with 4–5 green glabrous sheathing bracts; **leaf sheaths** green, glabrous; **ligule** 1–2 mm long, almost inconspicuous, bilobed, green, tomentose; **petiole** reduced to pulvinus, c. 2–3 mm long, light green, tomentose; **lamina** to 15–22 × 2–4 cm (largest leaves of mature flowering individuals measured; dimensions when dried 14–20 × 1.8–2.8 cm), narrowly ovate, gradually tapering to a narrowly attenuate-narrowly caudate apex, base obtuse to rounded, above dark glossy green and glabrous, lighter green and glabrous beneath (except occasional space hairs near the midrib and the basal part near pulvinus). **Inflorescence** radical, to 23 cm long, erect; **peduncle** 5–10(–12) cm (comprising half of the length of the entire inflorescence); sheathing bracts 4–6, 0.5–3 cm long (basalmost shortest at c. 5 mm, gradually longer towards the spike), tubular at base (2–10 mm), cream-white to light green (those below the leaf litter layer cream-coloured, those above ± light green), with orange-reddish tinge in upper bracts, softly pubescent (hairs appressed); **spike** 7–11 × 1.5(–2) cm broad (dimensions when dried 7–11 × 1–1.3 cm), narrowly fusiform, consisting of 8–17 bracts (lowermost and uppermost 2 bracts usually sterile); **fertile bracts** slightly obovate, lower bracts up to 3.6 × 2.3 cm (gradually smaller towards the apex), with broadly acute to obtuse apex, externally cream-white to light yellow at base, richly tinged orange-red in upper exposed parts, softly pubescent (hairs appressed), internally light yellow, glossy, glabrous, margin c. 0.5 mm, hyaline, translucent white, enclosing single flower; **bracteole** much reduced, to 2–7 mm long, 2–5 mm wide at base, triangular, translucent white, externally with sparse soft white appressed hairs, internally glabrous. **Flower** 6–7 cm long; **calyx** 13–20 mm long, cylindric in basal third, inflated in apical part, with three inconspicuous teeth, incised unilaterally 6–10 mm, translucent white, sparsely pubescent towards the ovary, glabrous in apical half; **floral tube** 35–42 mm long, cream-white at base, yellowish towards apex; **dorsal corolla lobe** ovate-triangular, 26–28 × 9–11 mm, translucent pale yellow, glabrous, apex narrowly acuminate, with inflexed margins, rarely minutely cuculate; **lateral corolla lobes** narrowly ovate-triangular, 23–25 × 5–7 mm, translucent pale yellow, glabrous, apex narrowly acuminate, with inflexed margins; **labellum** 21–23 mm long, 9–11 mm wide (18–20 mm wide inclusive of the lateral staminodes which are connate to the labellum and form a trilobed structure), pale yellow, glabrous; **lateral staminodes** 13–14 × 4–5 mm, connate to labellum in basal $\frac{4}{5}$, pale yellow, glabrous. **Stamen** 18–20 mm long (without straightening out the anther crest); **filament** 1–1.5 mm long; **anther** c. 11 × 4 mm (excluding the crest), connective tissue cream-white, anther crest 11–13 mm long (straightened), exceeding stigma by 1–3 mm, cream-white to pale yellow at base, slightly darker towards apex;



Fig. 1. *Zingiber singapurense* Škorničk. **A.** Habit. **B.** Inflorescence. **C.** Rooting plantlet arising from the apical part of the leafy shoot. **D.** Detail of ligule. From type SNG-178. (Photos: Jana Leong-Škorničková)

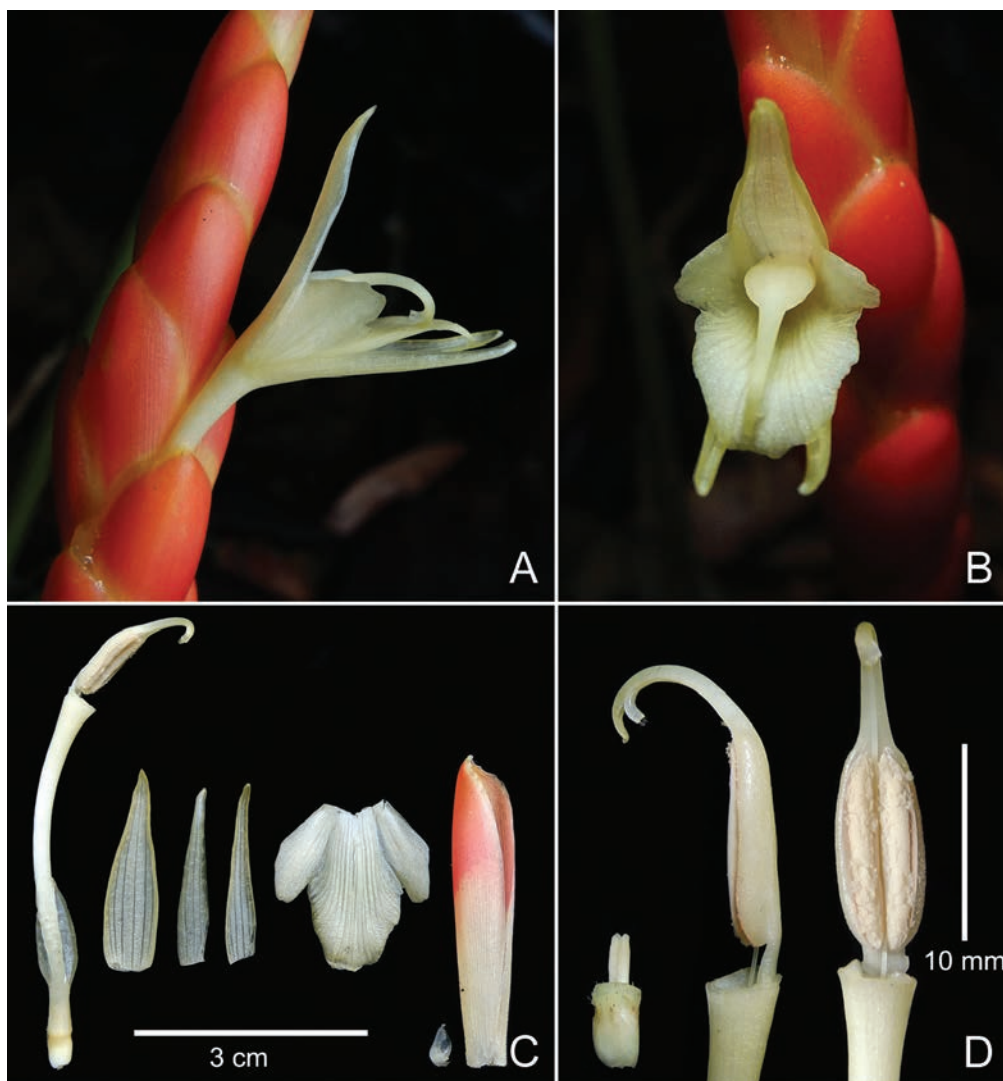


Fig. 2. *Zingiber singapurense* Škorničk. **A.** Flower (side view). **B.** Flower (front view). **C.** Flower dissection (from left): Floral tube with ovary, calyx and anther attached, dorsal corolla lobe, two lateral corolla lobes, labellum with connated lateral staminodes, bracteole, fertile bract. **D.** Detail of ovary with epigynous glands, anther (side view) and anther (front view). From type *SNG-178*. (Photos: Jana Leong-Škorničková)

anther thecae dehiscent along entire length. **Epigynous glands** two, c. 3.5 mm long, c. 0.75 mm in diam., cream-white. **Ovary** 3–4 × 2–3 mm, cream-white, pubescent, hairs light rusty brown; **style** white, stigma with round, forward-facing ciliate ostiole. **Fruits** not seen.

Ecology and phenology. *Zingiber singaporense* occurs in primary and mature secondary forest, preferring moist and shady conditions. Flowering in May–June.

Distribution. So far endemic to Singapore.

Etymology. The specific epithet of this small and vulnerable yet resilient species is derived from Singapore's name in Malay, 'Singapura'.

Additional specimens examined. SINGAPORE: Central Catchment Nature Reserve, MacRitchie sector, 21 May 2014, *J. Leong-Škorničková & Aung Thame GRC-179* (E, SING); 29 May 2014, MacRitchie sector, *J. Leong-Škorničková & Aung Thame GRC-180* (E, SING);

Provisional IUCN conservation assessment & conservation strategy. So far only three populations in the Central Catchment Nature Reserve have been discovered with each population only having 10–25 mature individuals and less than 50 mature individuals in total. The Extent of Occurrence (EOO) is 0.06 km². High visitor numbers and proposed development plans could adversely affect the quality of the habitat. Following the IUCN criteria (IUCN, 2012) and the criteria for national conservation assessments as outlined by Davison (2008), *Zingiber singaporense* should be considered nationally and globally Critically Endangered (B1ab(iii,iv,v); D).

Although the leafy shoots of most Zingiberaceae are pseudostems composed of leaf sheaths, true stems with buds, capable of producing bulbils or seedlings, have been reported in some *Globba* and *Zingiber* species. The stems of *Zingiber singaporense* are arching, a feature more prominent in older stems. The tips eventually touch the ground and new plantlets grow from the buds (Fig. 1C). This capability to reproduce vegetatively makes *Zingiber singaporense* less dependent on the presence of pollinators and is certainly a reason behind its resilience. However, it does appear that the populations also reproduce from seeds (assumed from the presence of small independent plantlets not physically connected to adult individuals). Nothing is currently known of the genetic diversity in the three existing populations although such work is planned in the near future. Work on DNA barcoding of all native Zingiberales is also in progress (Khew et al., unpublished).

The existing populations will continue to be closely monitored for fruit-set and the numbers of seedlings and vegetatively produced offsprings. By selective harvesting of young plantlets from overcrowded parts of the populations the chances of survival of the remaining plantlets in the field improves. The harvested plantlets will be replanted in Singapore Botanic Gardens as stock for *ex situ* conservation. Currently, about 15 plants have been successfully established in the *ex situ* native gingers germplasm collection at the Singapore Botanic Gardens. These are individuals from all three populations to retain as much of the original genetic variation as possible. The establishment of cuttings from stem buds and of *in vitro* propagation to bulk up the number of plants is also in progress. These should produce enough stock for re-introductions into suitable habitats as well as for its introduction into the horticulture trade to lower the risk of illegal harvesting from the wild populations.

Notes. *Zingiber* is the largest genus in the sub-family Zingiberoideae with more than 200 names corresponding to approximately 100–150 species (Wu & Larsen, 2000; Kishor & Leong-Škorničková, 2013). The genus is well characterised by lateral staminodes connate to the labellum, an elongated horn-like anther crest wrapped around the stigma, and the presence of a pulvinus. *Zingiber* has been traditionally divided into four sections based on the position of the inflorescence (*Zingiber* sect. *Zingiber*, sect. *Dymczewiczia* (Horan.) Benth., sect. *Pleuranthesis* Benth. and sect. *Cryptanthium* Horan.). While a recent molecular study based on a single marker and limited material hints that *Zingiber* sect. *Dymczewiczia* and *Zingiber* sect. *Pleuranthesis* are not well segregated from *Zingiber* sect. *Zingiber* (Theerakulpisut et al., 2012), the old classification remains in use until a new classification is formally proposed.

In its general habit and the position of the inflorescence, *Zingiber singaporense* falls clearly into *Zingiber* sect. *Zingiber*. In its narrowly fusiform orange to red inflorescences and pale yellow flowers, it can be further narrowed to the group of species in the *Zingiber gracile* alliance (for a key to *Zingiber* in Peninsular Malaysia see Theilade, 1998). The complexity of this group in Peninsular Malaysia was previously noted by Holttum (1950), who recognised four varieties (*Zingiber gracile* var. *gracile*, *Z. gracile* var. *aurantiacum* Holttum, *Z. gracile* var. *elatus* Ridl. and *Z. gracile* var. *petiolatum* Holttum). Theilade (1998), who revised the genus *Zingiber* for Peninsular Malaysia, upgraded all varieties to the specific level (*Z. gracile* Jack, *Z. aurantiacum* (Holttum) Theilade, *Z. elatus* (Ridl.) Theilade and *Z. petiolatum* (Holttum) Theilade). Theilade also described an additional species from this group, *Zingiber sulphureum* Burkill ex Theilade (Cowley & Theilade, 1995). Lim (2003) added another two species with narrowly fusiform inflorescences to this group, *Zingiber raja* C.K.Lim & Kharuk. and *Z. kelantanense* C.K.Lim.

Of the seven species in the *Zingiber gracile* alliance, four have elliptic to ovate laminae with an approximate length:width ratio of < 4.5. The large *Zingiber raja* (type from Perak, Belum F.R.), with pseudostems to 2.5 m tall and elliptic laminae (length:width ratio 3.6–4.23; based on the protologue), can be excluded on account of its very long inflorescences (peduncles to 62 cm, spikes to 36 cm), markedly distinct dark maroon labellum, and staminodes with yellow blotches. *Zingiber kelantanense* (type from Kelantan, Stong F.R.) is also a large species to 2.5 m in height, with elliptic, plicate and prominently petiolate laminae (length:width ratio 3–4.1; based on the protologue). The following two species are smaller in habit to 1 m in height. *Zingiber gracile* (type from Penang), stands out in this group due to its long, papery, thin ligules (up to 1.8 cm in the type herbarium material) and elliptic lamina (to 16 × 4.2 cm, length:width ratio 3.8; based on the lectotype) and well-developed bracteoles (c. 20–25 mm long). *Zingiber sulphureum* (type from Taman Negara) differs in its elliptic to ovate, abaxially hairy lamina (to 15 × 5 cm, length:width ratio 3; based on an isotype), sulphur yellow bracts at anthesis, prominently bilobed papery ligules to 6 mm long and completely missing bracteoles.

Zingiber singaporense has dark green, narrowly ovate to narrowly elliptic laminae (14–20 × 1.8–2.8 cm, length:width ratio 7.1–7.8; based on herbarium material of the holotype and isotypes) and short ligules, therefore in general habit similar to the

remaining three species. Delimitation of *Zingiber singaporense* within this group is, however, straightforward as it is the only species which has much reduced triangular bracteoles (to 2–7 mm long) and distinctly convex bracts, giving the inflorescence a bullate appearance (Fig. 1B). It is also the smallest and most delicate species in the group, with leafy shoots to 1.5 m long, but distinctly arching and not exceeding 0.8 m in height. The bracteoles are well developed in *Zingiber aurantiacum* (c. 25 mm), *Z. elatius* (25–30 mm) and *Z. petiolatum* (c. 30 mm). *Zingiber petiolatum* (type from Kedah) is a much larger species, up to 3 m tall, with somewhat petiolate leaves up to 34/40 × 5.5 cm, and inflorescences up to 86/110 cm long, inclusive of the spike to 34/44 cm long (measured from the lectotype/isolectotype; lamina length:width ratio 6.2/7.2). *Zingiber elatius* (type from Penang Hill) is clearly distinct in the inflorescence composed of a long peduncle (to 36 cm; in type material), an ovoid spike composed of bronze to red-purple bracts (c. 11 × 2.6 cm; in isolectotype), and flowers with a pale yellow labellum ornamented with fine dark purple lines and tinged in the centre. The lamina length:width ratio is c. 10 (Fig. 3A, B). *Zingiber aurantiacum* (type from Pahang, Fraser's Hill), is a more robust, montane species up to 2 m tall, with larger leaves (to 26 × 4.1 cm, length:width ratio c. 6.2; based on the lectotype), reddish leaf-sheaths in young shoots, larger inflorescences (to 43 cm in type material) with tightly appressed bright orange fertile bracts at anthesis, and lateral staminodes almost fully connate with the labellum (Fig. 3C, D).

Key to species from the *Zingiber gracile* alliance
in Peninsular Malaysia and Singapore

- 1a. Lamina elliptic to ovate (length:width ratio < 4.5) 2
- 1b. Lamina narrowly ovate to narrowly elliptic (length:width ratio > 6) 5

- 2a. Ligules short (c. 2 mm), labellum and staminodes dark maroon with yellow blotches *Z. raja*
- 2b. Ligules 4–22 mm, flowers light yellow 3

- 3a. Plant to 2.5 m tall, lamina petiolate, prominently plicate *Z. kelantanense*
- 3b. Plant to 1 m tall, lamina ± sessile, smooth or weakly bullate 4

- 4a. Ligules to 18 mm, fertile bracts orange to pink at anthesis, bracteoles well developed *Z. gracile*
- 4b. Ligules 4–6 mm, fertile bracts sulphur yellow at anthesis, bracteoles absent
..... *Z. sulphureum*

- 5a. Bracts prominently convex, bracteoles reduced (to 7 mm long)
..... *Z. singaporense*
- 5b. Bracts tightly appressed, bracteoles well-developed (25–30 mm) 6

- 6a. Spike ovoid, bracts bronze to red-purple at anthesis, labellum pale yellow ornamented by fine dark purple lines and tinged in the centre *Z. elatius*
- 6b. Spike narrowly fusiform, bracts orange to rose-pink at anthesis, labellum plain pale yellow 7
- 7a. Leafy shoots 2–3 m tall, inflorescence to 110 cm long (peduncle to 65 cm long, spike to 44 cm long) *Z. petiolatum*
- 7b. Leafy shoots 1–2 m tall, inflorescence to 56 cm long (peduncle to 40 cm long, spike to 16 cm long) *Z. aurantiacum*

The genus *Zingiber* in Singapore

In Singapore only two *Zingiber* species are currently considered native: *Zingiber griffithii* Baker and *Zingiber puberulum* Ridl. Both are easy to distinguish from *Zingiber singaporense* even when sterile (Fig. 4). *Zingiber griffithii* has leafy shoots 0.5–0.8 m tall, with 5–8(–10) leaves per shoot, leaf sheaths almost glabrous at base, with sparse long silky appressed hair at apical part, lamina elliptic, thin, bright green, slightly plicate, c. 12–25 × 5–8 cm, with long silky appressed hairs abaxially. *Zingiber puberulum* is a more robust species with leafy shoots up to 2 m tall, with up to 23 leaves per shoot, leaf sheaths puberulous to pubescent, lamina elliptic, slightly leathery, mid to dark green, sometimes with dull silvery finish, almost flat (plication negligible), c. 20–35 × 5–8 cm, adaxially puberulous. *Zingiber singaporense* is a delicate plant, not exceeding 0.8 m in height (though its arching leafy shoots might be up to 1.5 m long), with 18–26 leaves per shoot, lamina narrowly ovate, slightly leathery, dark glossy green, flat (not plicate) 15–22 × 2–4 cm, glabrous adaxially, lighter green and almost glabrous abaxially (except occasional space hairs near the midrib and the basal part near pulvinus). The above measurements given are from living material in Singapore populations.

The habit of *Zingiber singaporense* blends very well with other understorey vegetation and at first glance is reminiscent of young palm fronds or even some terrestrial orchids (e.g. *Bromhaedia finlaysoniana* (Lindl.) Miq.). Unless it is flowering it is fairly hard to spot this rare species, which is likely the reason why it has been overlooked until now.

Three varieties of *Zingiber puberulum* are currently recognised (Holttum, 1950; Theilade 1998), *Z. puberulum* var. *puberulum*, *Z. puberulum* var. *chryseum* (Ridl.) Holttum and *Z. puberulum* var. *ovoideum* (Ridl.) Holttum), of which two are based on Singapore material. *Zingiber puberulum* var. *puberulum* was described from material collected in Bukit Timah Nature Reserve (Singapore) where it is still present. All extant Singapore material of this species belongs to this variety. *Zingiber puberulum* var. *chryseum* was described in 1908 by Ridley (as *Z. chryseum*) from the woods in the Stagmount area (Singapore). The forest in this area was cleared shortly thereafter and no further material of this taxon has ever been collected. It is presumed, therefore, to



Fig. 3. *Zingiber elatius* (Ridl.) Theilade, photographed at Penang Hill (type locality). **A.** Habit and detail of ligule (inset). **B.** Inflorescence and detail of flower (inset). *Zingiber aurantiacum* (Holttum) Theilade, photographed at Fraser's Hill (type locality). **C.** Habit and detail of ligule (inset). **D.** Inflorescence and detail of flower (inset). (Photos: Jana Leong-Škorničková)

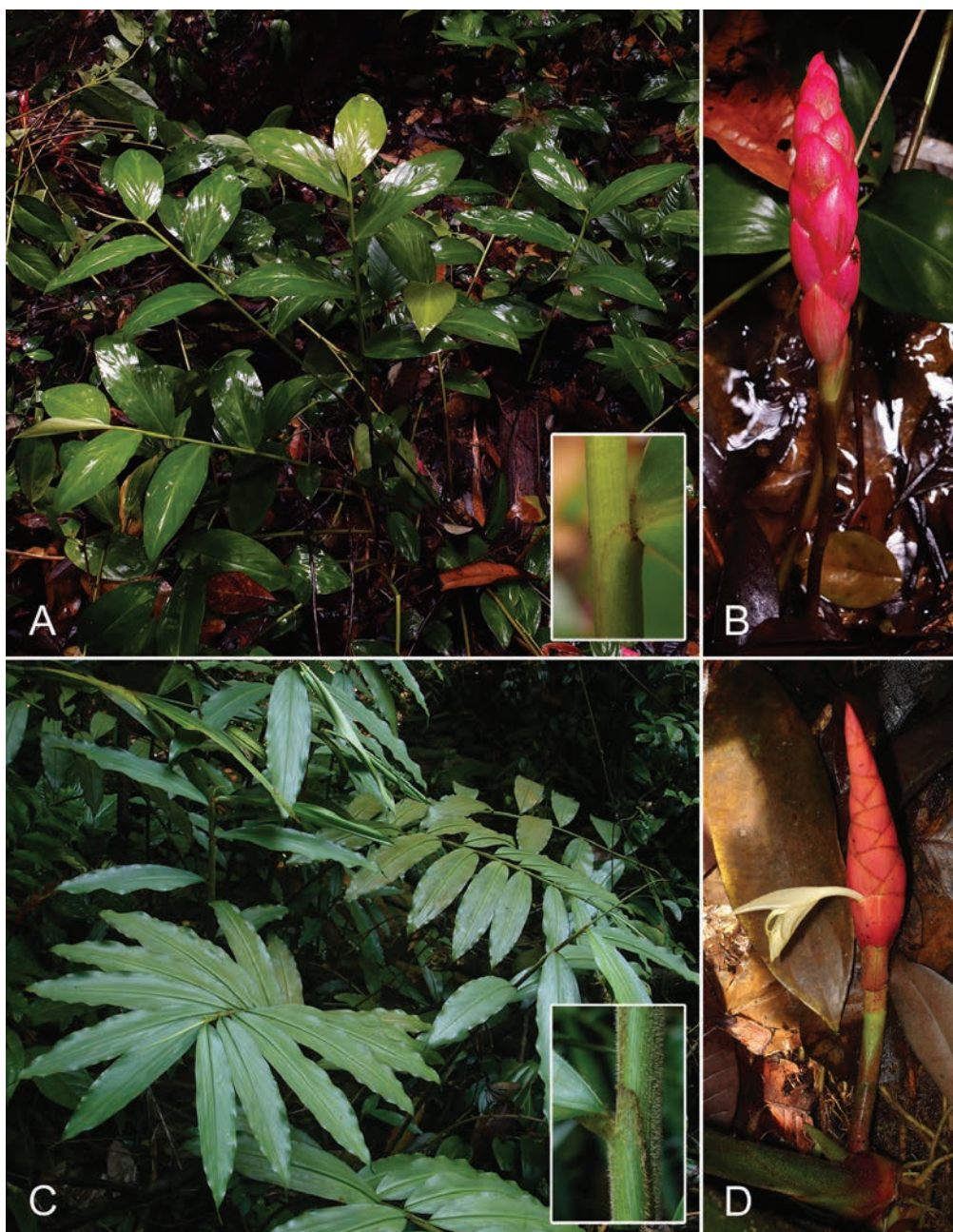


Fig. 4. *Zingiber griffithii* Baker, photographed in Bukit Timah Nature Reserve, Singapore (SNG-127). **A.** Habit and detail of ligule (inset). **B.** Inflorescence shortly after flowering. *Zingiber puberulum* var. *puberulum* Ridl., photographed in Bukit Timah Nature Reserve, Singapore (type locality; SNG-91). **C.** Habit and detail of ligule (inset). **D.** Inflorescence (image rotated 90° counter clock-wise). (Photos: Jana Leong-Škorničková)

have gone extinct in Singapore. *Zingiber puberulum* var. *ovoideum* was described by Ridley from material collected in Pahang and so far this taxon has been only reported from Peninsular Malaysia (Kelantan, Perak and Pahang). Its record for Singapore by Chong et al. (2009) is an error and should be corrected to *Z. puberulum* var. *puberulum*.

Zingiber ottensii Valetton (previously recorded as *Z. zerumbet* e.g. by Keng et al., 1998; Chong et al., 2009) has been reported growing in gardens and waste ground (Keng et al., 1998), and later listed as casual (a sub-category of an exotic species) in a Checklist of the total vascular plant flora of Singapore (Chong et al., 2009). As with many other widely utilised gingers, the exact origin of *Zingiber ottensii* is unclear, though it is clearly native to SE Asia. This species is distributed in the evergreen Malesian region, compared to the closely related *Zingiber zerumbet* (L.) Sm. which is mostly confined to South Asia and monsoonal parts of Southeast Asia (Indochinese region). The two species are indeed very similar when sterile and practically indiscernible in herbarium material even if an inflorescence is present unless good notes on the flowers are provided. It is, therefore, not surprising that these are often confused. *Zingiber ottensii* when flowering can be readily distinguished from *Z. zerumbet* by the rusty purple-brown colour of the bracts (compared to bright green bracts of *Z. zerumbet*), and by the labellum and staminodes, which are tinged by pale purple to violet and have pale yellow blotches (compared to the pure cream-yellowish labellum and staminodes of *Z. zerumbet*) (Fig. 5). So far we have seen numerous populations of *Zingiber ottensii* freely growing in several locations in Singapore but have not observed any populations of *Zingiber zerumbet*.

Key to native and naturalised *Zingiber* species in Singapore

- 1a. Spike ovoid, bracts rusty purple brown at anthesis, peduncle equal or more than double the length of spike (> 15 cm long), labellum and staminodes tinged by light purple to violet, with light yellow blotches *Z. ottensii*
- 1b. Spike fusiform, bracts pink, orange or red at anthesis, peduncle as long or shorter than spike (< 15 cm), labellum and staminodes uniformly pale yellow 2
- 2a. Plant less than 1.5 m tall, bracteole less than 6 mm or absent 3
- 2b. Plant over 1.5 m tall, bracteole more than 10 mm *Z. puberulum*
- 3a. Lamina elliptic, bright green, thin, weakly plicate, beneath with long silky appressed hair, bracteoles absent *Z. griffithii*
- 3b. Lamina narrowly ovate, dark green, slightly leathery, flat (not plicate), glossy, glabrous beneath, bracteoles reduced (2–7 mm long) *Z. singaporense*

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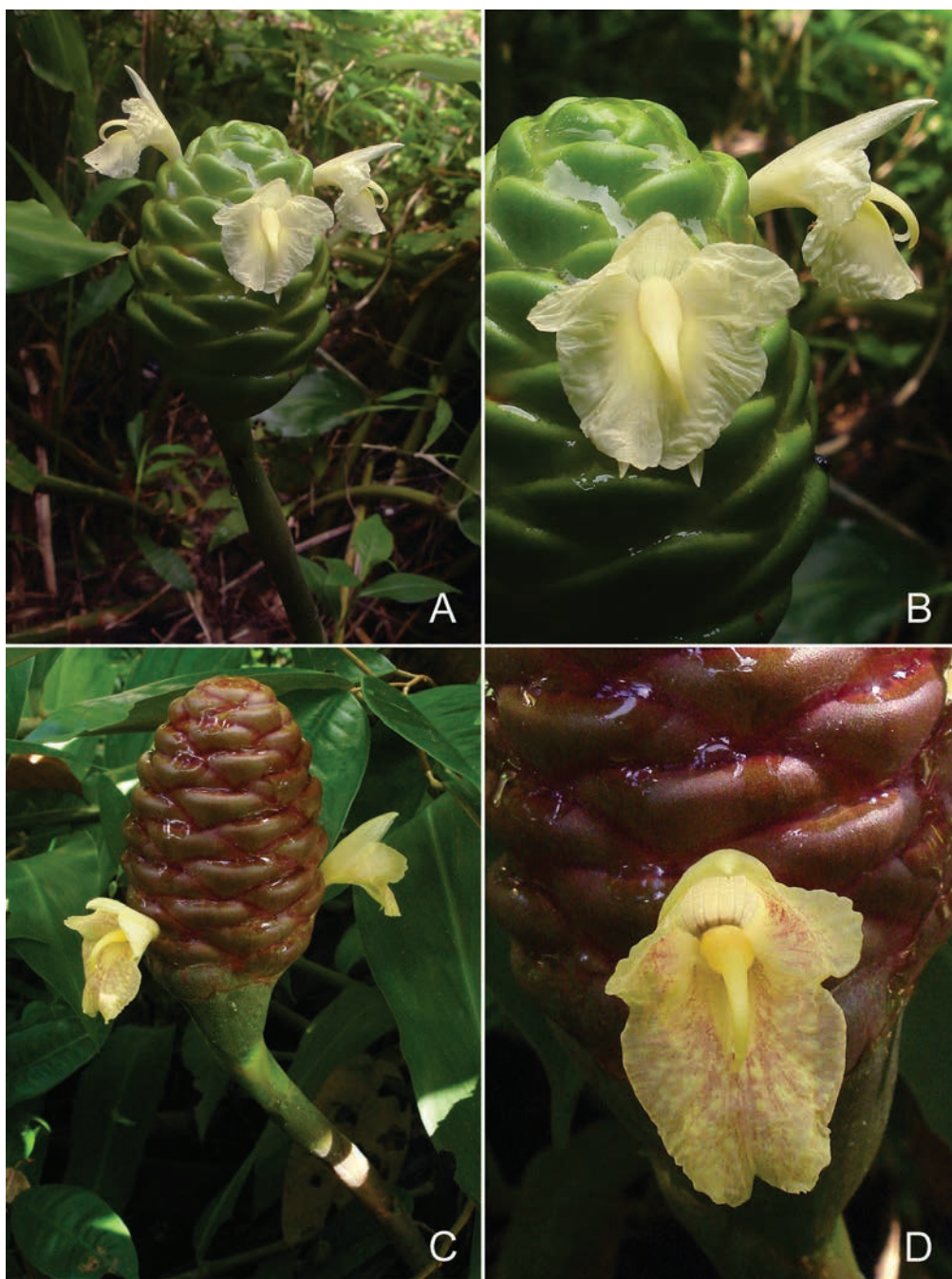


Fig. 5. *Zingiber zerumbet* (L.) Sm., photographed in southern Vietnam. **A.** Inflorescence. **B.** Flower (front view). *Zingiber ottensii* Valetton, photographed in Singapore, outskirts of Bukit Timah Nature Reserve. **C.** Inflorescence. **D.** Flower (front view). (Photos: Jana Leong-Škorničková)

generous funding of our project ‘Enhancement of Biodiversity Research for Ginger’ (January 2011 – March 2012) through the Urban Ecology RF programme. This enabled extensive surveys across Singapore leading to this and other exciting discoveries, as well as mass propagation of material of various native Zingiberales for re-introductions. Our sincere thanks are due to numerous NParks staff and volunteers, who continuously supported us in the field during plant collections and regular monitoring, in particular: Mishak Sunari (Sungei Buloh Wetland Reserve), Derek Liew, Chung Yi Fei, William Ng and Ngon Soon Kong (all Central Catchment Nature Reserve), Trần Hữu Đăng (ex staff of Singapore Botanic Gardens), Sunia Teo (Singapore Botanic Gardens), Michael Leong (volunteer, Singapore Botanic Gardens). We also thank Adelle Wang (Bukit Batok Nature Park), Desmond Lee (Sungei Buloh Wetland Reserve) for their active approach in re-introduction programmes, and Koh Teng Seah and Dr Gillian Khew (both Singapore Botanic Gardens) for supporting *in vitro* propagation of native ginger at Singapore Botanic Gardens. We also thank Dr Axel Poulsen and an anonymous reviewer for critical comments and suggested improvements to this manuscript, Dr David Middleton, Editor of Gardens’ Bulletin Singapore, for language improvements and navigating the paper through the review process, and the curators of KEP and SING herbaria for allowing us to examine relevant herbarium material.

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