

New records and rediscoveries of vascular plants in Bukit Timah Nature Reserve, Singapore

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ABSTRACT. Several new records of plant species previously unknown in Singapore are reported, along with records of species presumed to be nationally extinct which have been rediscovered. These reports are based on specimens collected during our recent surveys of the Bukit Timah Nature Reserve and previously unreported older specimens, all deposited in SING. Three species are reported as new records for Singapore: *Scindapsus lucens* Bogner & P.C.Boyce, *Passiflora quadriglandulosa* Rodschied and *Tectaria nayarii* Mazumdar. *Scindapsus lucens* is likely to be native and previously overlooked, whereas *Passiflora quadriglandulosa* and *Tectaria nayarii* are exotic species which have escaped from cultivation and become naturalised. Another 10 species are rediscoveries of taxa previously considered to be nationally extinct: *Aglaia palembanica* Miq., *Bolbitis sinuata* (C.Presl) Hennisman, *Calamus ornatus* Blume, *Claoxylon longifolium* (Blume) Endl. ex Hassk., *Dapania racemosa* Korth., *Dioscorea kingii* R.Knuth, *Ficus rosulata* C.C.Berg, *Lasianthus reticulatus* Blume, *Ryparosa hullettii* King and *Senegalia kekapur* (I.C.Nielsen) Maslin, Seigler & Ebinger.

Keywords. Exotics, floristic survey, native

Introduction

Bukit Timah Nature Reserve (BTNR) has long been a site of botanical research in the heart of mainland Singapore, with the last comprehensive survey of the biodiversity in BTNR published in 1995 (Chin et al., 1995). An opportunity to conduct new surveys in order to update our understanding of the biodiversity of BTNR recently arose due to the temporary closure of the Reserve to the public for restoration and enhancement work from 2014 to 2016.

A total of 1047 species of vascular plants was recorded for the 163-hectare reserve by Turner & Chua (2011), including many with a conservation status of Critically Endangered or which have been considered to be nationally extinct in

Singapore. During our botanical survey in BTNR, we collected several species that are listed in Davison et al. (2008) as nationally extinct, defined as a species that has not been collected or recorded for at least 30 years for vascular plants. These species are therefore reported here as rediscoveries for Singapore. We have also come upon a number of specimens collected prior to our survey work of species which are considered to be nationally extinct but which have been re-collected in BTNR since 2008 and have so far been unreported in the literature. We take this opportunity to also report these as rediscoveries. In summary, we here report one new record of a native species, two new records of exotic naturalised species, and 10 rediscoveries of native species that were thought to be nationally extinct in Singapore.

BTNR remains an important refuge for many rare native species. The many rediscoveries emphasise the conservation significance of the last few remaining primary forest patches in Singapore. Future detailed field studies and visits to the nature reserve will surely result in the discovery of more native species that are presumed to be nationally extinct in Singapore. Maintenance of high levels of biodiversity at BTNR continues to be threatened by isolation, fragmentation and by exotic invasive species, but the effects of these threats can only be understood and perhaps mitigated by better research based on a good understanding of what is there. Based on the criteria set out in Davison et al. (2008), all species listed below, except for the two that have naturalised, should be considered to be Critically Endangered in Singapore as fewer than 50 individuals are known for any of them in the country.

New native species records for Singapore

***Scindapsus lucens* Bogner & P.C.Boyce (Araceae) (Fig. 1A–B)**

A population of this species was encountered creeping and scrambling on the humid forest floor in BTNR, forming a loose ground cover under the shade of the forest canopy (Fig. 1A). Some shoots were climbing up trees to about 4 m above ground, at times dangling freely from the trees. It is on one of these free-dangling shoots that a terminal spadix was found and collected (Fig. 1B). Although the deciduous spathe had fallen, the species is distinct among known species of *Scindapsus* Schott in its bullate adaxial leaf surface. The same species, though sterile, has also been found in Nee Soon Swamp in a similar habitat.

Scindapsus hederaceus Schott and *S. pictus* Hassk. were previously the only known species in the genus in Singapore (Chong et al., 2009). *Scindapsus hederaceus* differs from both *S. lucens* and *S. pictus* in its oblong-lanceolate leaf blade attached to a conspicuously winged petiole. *Scindapsus lucens* most closely resembles *S. pictus*, a common species in BTNR, as both have coriaceous asymmetrical cordiforme leaf blades, slightly caniculate petioles and roughened stems. However, in *Scindapsus lucens* the leaf blades are pale grey to pale jade green above and never variegated with silvery jagged spots or patches with a darker green background as often observed in those of *S. pictus*. The adaxial leaf surface in *Scindapsus lucens* is glossy, while that of



Fig. 1. *Scindapsus lucens* Bogner & P.C.Boyce. **A.** A population at BTNR forming a loose ground cover. **B.** Terminal spadix inflorescence, note that the spathe has fallen off and each penta-hexagon represents a truncate flower from top view. From *Ho et al. BT2016-004*. (Photo: A, P.K.F. Leong; B, H.K. Lua)

S. pictus is matte to somewhat glistening. The stem of *Scindapsus lucens* is warty and remains green even in older parts, whereas that of *S. pictus* is slightly rough to the feel with the older parts becoming brown with flaking epidermis.

Scindapsus lucens was first described from cultivated material of unknown origin (Bogner & Boyce, 1994). Wild populations were found later in lowland areas of Sumatra and Peninsular Malaysia (Ahmad Sofiman et al., 2010). Its occurrence in Singapore is not unexpected. The Singapore populations of *Scindapsus lucens* have leaves smaller than the descriptions given in Bogner & Boyce (1994) and Ahmad Sofiman et al. (2010) (smallest 4 cm long and 3 cm wide including the 1–1.5 cm cuspidate apex).

Specimens examined. SINGAPORE: **BTNR:** 5 Jan 2016, *Ho et al.* BT2016-004 (SING [SING0232311]). **Nea Soon:** 10 Mar 2016, *Ho et al.* SING 2016-067 (SING [SING0234521]).

New naturalised species records for Singapore

1. *Passiflora quadriglandulosa* Rodschied (Passifloraceae) (Fig. 2)

Specimens of this species have been collected from BTNR on three occasions since 2014, including during our recent survey. It is an exotic escape from cultivation as it is native to northern South America (Killip, 1938). Specimens in SING have previously been wrongly identified as *Passiflora vitifolia* Kunth, a species easily confused with *P. quadriglandulosa*. Leaves in both species are variable in shape, ranging from unlobed to asymmetrically bilobed, to trilobed, usually with coarsely and irregularly toothed margins (Fig. 2). The easiest way to separate them is that *Passiflora vitifolia* is densely pubescent, while *P. quadriglandulosa* is essentially glabrous, with scanty very fine hairs limited to the leaf veins when present. Another difference is that the floral bracts in *Passiflora quadriglandulosa* are linear-lanceolate and up to 5 mm long, while those of *P. vitifolia* are oblong-lanceolate and usually 5–10 mm long (Killip, 1938). In our collections the corolla is pink (Fig. 2).

Specimens examined. SINGAPORE: **BTNR:** 19 May 2014, *Lua* SING 2014-211 (SING [SING0212392]); *ibid.*, 14 Apr 2015, *Leong-Škorničková et al.* SING 2015-109 (SING [SING0213877]); *ibid.*, 31 Jan 2017, *de Wilde et al.* SING 2017-029 (SING [SING0239563]).

2. *Tectaria nayarii* Mazumdar (Tectariaceae) (Fig. 3)

Better known in the literature as *Heterogonium pinnatum* (Copel.) Holttum, this small limestone-loving fern, which is native to Southern Thailand, Peninsular Malaysia, Borneo, Sumatra and the Philippines, has been growing in shady coralline rockeries at Singapore Botanic Gardens for more than 60 years (Holttum, 1955; Tan & Ng, 2012) but has not previously been reported outside the Botanic Gardens. In August 2017 we discovered a small population of *Tectaria nayarii* growing in the crevices of moss-

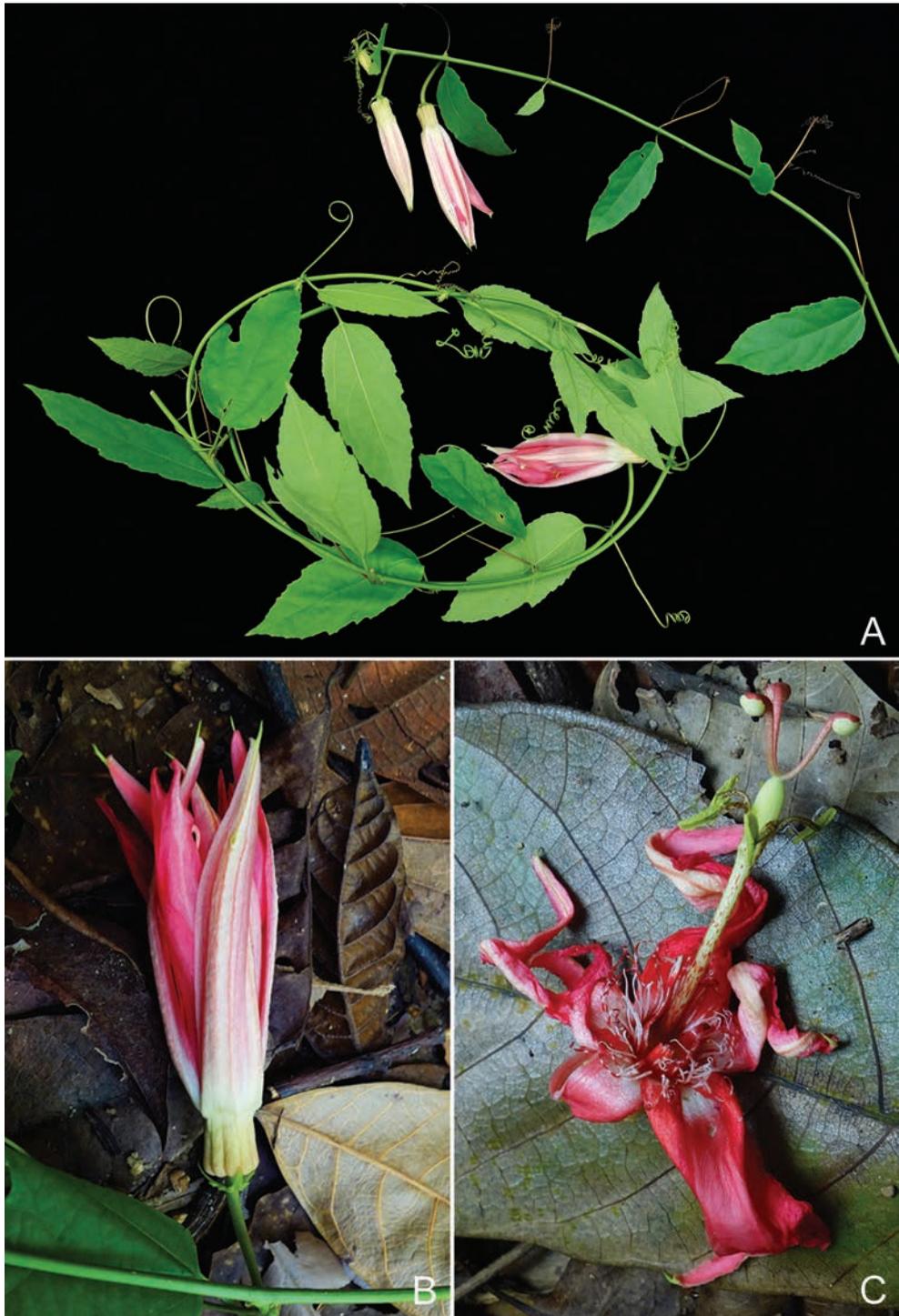


Fig. 2. *Passiflora quadriglandulosa* Rodschied collected from BTNR. **A.** Flowering branches before pressing and drying. **B.** Detail of unopened flower in side view. **C.** Detail of old flower. A from Lua SING 2014-211; B & C from Leong-Škorničková *et al.* SING 2015-109. (Photos: A, P.K.L. Leong; B & C, J. Leong-Škorničková)



Fig. 3. *Tectaria nayarii* Mazumdar growing in the crevices of a moss-covered calcareous bolder. From *Lindsay et al. 2017-847*. (Photo: R.C.J. Lim)

covered calcareous boulders (possibly old concrete) near a stream in BTNR. None of the plants were fertile but the sterile fronds (the largest of which bore conspicuous adventitious buds) were easy to match with those of the plants at Singapore Botanic Gardens and in the herbarium. The presence of *Tectaria nayarii* in BTNR is undoubtedly due to naturalisation as the reserve has no natural limestone and the calcareous or concrete boulders to which the plants are restricted could very conceivably be rubble from a former village.

Specimens examined. SINGAPORE: **Singapore Botanic Gardens:** Jan 2012, *Ng 2012133* (SING [SING0200095]), *Ng 2012134* (SING [SING0200096]). **BTNR:** 2 Aug 2017, *Lindsay et al. 2017-847* (SING [SING0239584]).

Rediscoveries of native species from Singapore

1. *Aglaia palembanica* Miq. (Meliaceae) (Fig. 4A–D)

Only three specimens of this species have been found in SING (but note that Ridley (1900) suggests that Cantley's collections from Singapore may actually be from Peninsular Malaysia) and the last was collected in 1918. It has recently been

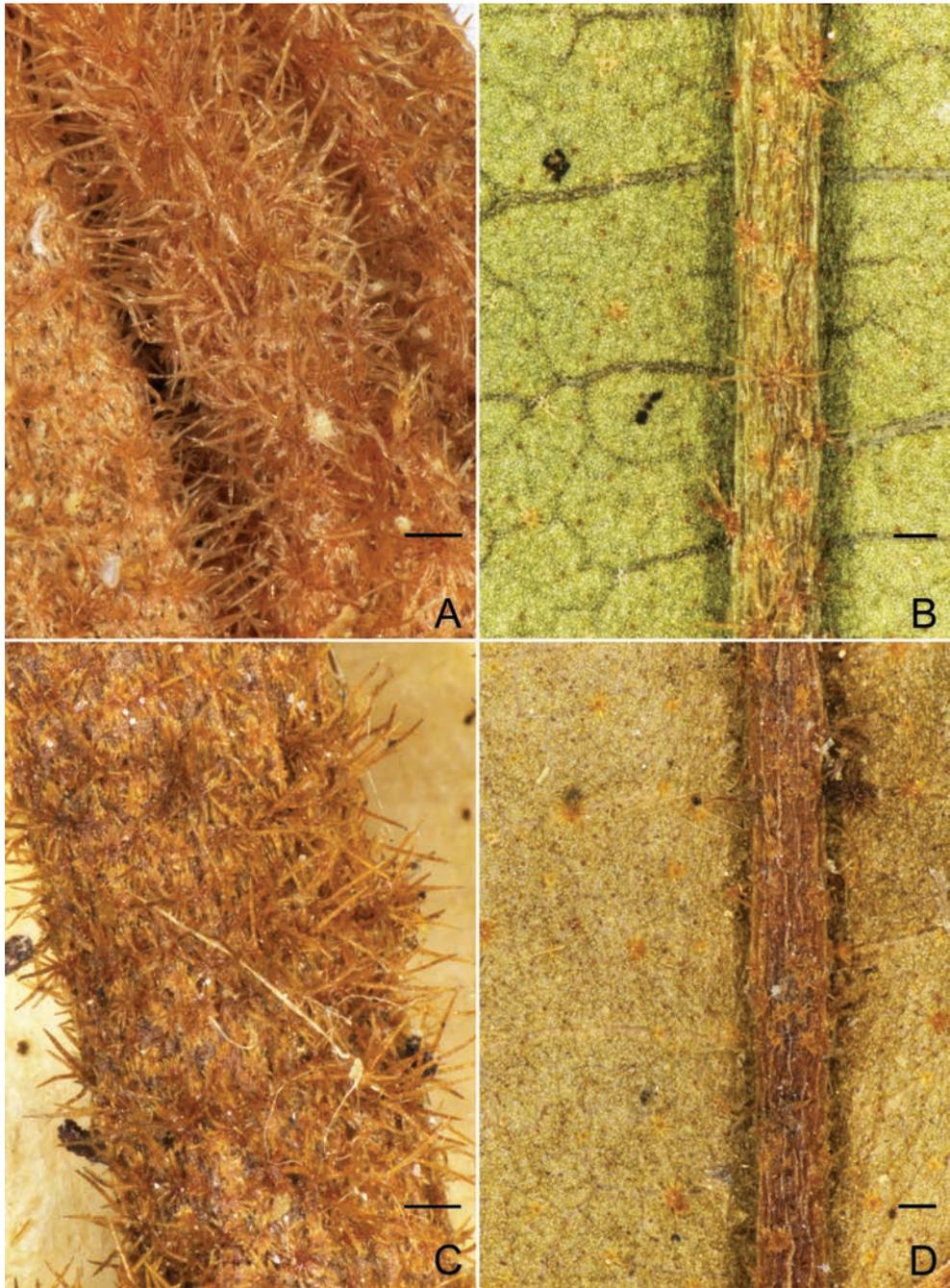


Fig. 4. Comparison of the indumentum on different plant parts of recent and past collections of *Aglaia palembanica* Miq. from BTNR. **A & C.** Brown stellate hairs with spreading (non-overlapping) arms on the twig apices. **B & D.** Brown stellate hairs and paler stellate or peltate scales with long fimbriate margins evenly scattered on the lower midrib and lamina. All scale bars = 0.25 mm. A–B, from *Ho et al. BT2017-012*; C–D from *Mohd Nur s.n.* (Photos: W.W. Seah)

rediscovered in our survey. This species may be distinguished by its narrowly elliptic to lanceolate leaflets with a distinctive type of indumentum on the lower leaflet midribs and laminas (Pannell, 1989, 1992, 2013). The indumentum consists of brown stellate hairs with spreading (usually non-overlapping) arms, interspersed with some paler stellate or peltate scales with a long fimbriate margin (Fig. 4). The shoot apices are also densely covered with the same type of indumentum. *Aglaia palembanica* typically has small compound leaves to around 35 cm long with 9–13 leaflets. According to Pannell (2013), this is a small, branched tree to 5 m tall and found in lowland dipterocarp forests to an elevation of 300 m.

Specimens examined. SINGAPORE: **BTNR:** 22 Oct 1918, *Mohd Nur s.n.* (SING [SING0169919]); *ibid.*, 28 Mar 2017, *Ho et al. BT2017-012* (SING [SING0239377]). **Stagmont:** Mar 1909, *Ridley 14140* (SING [SING0169917]). **Unspecified locality:** not dated, *Cantley's collector s.n.* (SING [SING0169918]).

2. *Bolbitis sinuata* (C.Presl) Hennisman (Dryopteridaceae)

This fern species was previously known from Singapore from collections made at what was possibly a single locality at Bukit Timah between 1880 and 1943 and from field observations published by Holttum in his *Flora of Malaya* (Holttum 1955, 1968). No further collections were made until a single juvenile plant was discovered in BTNR in 2012 and then a rather large population in 2017. While it is reassuring to know that *Bolbitis sinuata* is not extinct in Singapore it is a mystery why no collections of this species were made at Bukit Timah for almost 60 years, especially when it was reported to be “common on moss-covered granite boulders” by a particular stream in 1955 and 1968 and still is (Holttum 1955, 1968). *Bolbitis sinuata* is one of three species of *Bolbitis* in Singapore, the other two being *B. appendiculata* (Willd.) K.Iwats. and *B. heteroclita* (C.Presl) Ching. They all have dimorphic fronds, acrostichoid sori and a preference for wet, muddy or mossy rocks near streams although *B. sinuata* and *B. heteroclita* can occasionally be found climbing the bases of trees near streams. Note that *Bolbitis sinuata* is an extremely variable species (hence many synonyms including the very apt *B. diversifolia* (Blume) Schott); adult plants can have simple or pinnate fronds and sometimes both; the pinnate fronds can have 1–5 pairs of pinnae or just one, unpaired, pinna; the top-most pair of pinnae may or may not be fused with the terminal pinna to form a trident-shaped terminal segment; and the terminal or lateral pinnae may or may not bear vegetative buds.

Specimens examined. SINGAPORE: **BTNR:** Mar 1882, *Anonymous 60/103* (SING [SING0032505]); *ibid.*, 1893, *Ridley s.n.* (SING [SING0032507]); *ibid.*, 1907, *Ridley s.n.* (SING [SING0032499]); *ibid.*, 11 May 1924, *Holttum 10478* (SING [SING0032491]); *ibid.*, 12 Nov 1928, *Holttum 19800* (SING [SING0032492]); *ibid.*, Feb 1943, *Holttum s.n.* (SING [SING0032501, SING0032504]); *ibid.*, 17 Jul 2012, *Hassan & Hazwani SING 2012-327* (SING [SING0179448]); *ibid.*, 19 Apr 2017, *Ho et al. BT2017-010* (SING [SING0239578, SING0239579, SING0239580]); *ibid.*, 23 May 2017, *Ho et al. BT2017-017* (SING

[SING0239581]). **Unspecified locality:** Aug 1880, *King's collector 354* (SING [SING0032502, SING0032503]); *ibid.*, 22 Mar 1917, *Anonymous s.n.* (SING [SING0032500]).

3. *Calamus ornatus* Blume (Arecaceae) (Fig. 5A–B)

Eleven species of *Calamus* L. are known from Singapore (Chong et al., 2009), the majority being slender rattans with some having mutualistic relationships with ants. *Calamus ornatus* is one of the largest among the native *Calamus* species (another large species, *Calamus erinaceus* (Becc.) J.Dransf., is a mangrove associate). A robust clustering rattan with flagella (Fig. 5A), *Calamus ornatus* stands out among its native congeners by its large size and the wholly dark green leaf sheath (Furtado, 1956; Dransfield, 1979). The species was collected only twice in Singapore more than a century ago in 1892 and 1909. During our survey in BTNR, we encountered a population with several plants of varying ages. A third collection from Singapore was made from this population and it represents a rediscovery of the species. The stem has a diameter of up to 8 cm across; each leaf, excluding the petiole, is about 2.5 m long. Its leaf sheath develops a prominent knee-like swelling at the base of the petiole while a narrow, brown and becoming-tattered ochrea extends above the sheath apices (Fig. 5B). The leaves are pinnate and each has about 22 pairs of regularly spaced, alternate, lanceolate and hooded leaflets with the terminal ones progressively reduced but not clearly developing into a cirrus. Bukit Timah Nature Reserve remains the only known locality for this species in Singapore.

Specimens examined. SINGAPORE: **BTNR:** 1892, *Goodenough s.n.* (SING [SING0014635]); *ibid.*, Mar 1909, *Ridley 11484* (SING [SING0014634]); *ibid.*, 29 Dec 2017, *Loo et al.* SING 2017-830 (SING [SING0232238, SING0239374, SING0239375, SING0239376]).

4. *Claoxylon longifolium* (Blume) Endl. ex Hassk. (Euphorbiaceae) (Fig. 6A–B)

Claoxylon longifolium was formerly known from several parts of Singapore from collections made between 1885 and 1908 and was considered to be nationally extinct in the assessment by Tan et al. (2008). Subsequent collections made in 1931 and 1995 were not considered for this assessment because they had been misidentified as *Claoxylon indicum* (Reinw. ex Blume) Hassk., the only other *Claoxylon* species reported for Singapore. The confusion in identification of specimens of these two species is due to their superficial similarities in both sterile and fertile characters. However, the mature leaves of *Claoxylon longifolium* are at least twice as long as wide, the surface is glabrous or pilose (rough to the touch) and the petiole is up to 12.5 cm long (Fig. 6A), whereas those of *C. indicum* are at most twice as long as wide, the surface is velutinous (soft hairy to touch) and the petiole is up to 8 cm long (Van Welzen, 2017). Our collection of *Claoxylon longifolium* from BTNR confirms that this species is not extinct in Singapore but may now be confined only to BTNR. Our specimen also has infructescences measuring up to 7.5 cm long, with capsules about 1 cm across (Fig. 6B).



Fig. 5. *Calamus ornatus* Blume. **A.** The clustering habit of palm. **B.** Leaf sheath with tattering ochrea and flagella. All from BTNR. (Photos: A.H.B. Loo)

Specimens examined. SINGAPORE: **Jurong:** 1894, *Ridley 6103* (SING [SING0012724]). **Kranji:** 1894, *Ridley 6750* (SING [SING0040598]). **Bukit Mandai:** 1897, *Ridley 8911* (SING [SING0012719]). **Chua Chu Kang:** 1894, *Ridley 6818* (SING [SING082888]). **Bukit Panjang:** 1894, *Mat 5906* (SING [SING0012725]); *ibid.*, Apr 1908, *Ridley 13306* (SING [SING0012717]), *Ridley 13310* (SING [SING0012723]); *ibid.*, 17 Jul 1995, *Tang & Sidek 828* (SING [SING0016688]). **BTNR:** 1892, *Ridley 5035* (SING [SING0012722]); *ibid.*, 1892, *Ridley s.n.* (SING [SING0040597]); *ibid.*, 1894, *Ridley s.n.* (SING [SING0040600]); *ibid.*, 26 Feb 1931, *Mohd Nur 24643* (SING [SING0040600]); *ibid.*, 11 Apr 2017, *Ho et al. BT2017-013* (SING [SING SING0239378, SING0239379]). **Chan Chu Kang:** 1895, *Ridley 6822* (SING [SING0012718]). **Pulau Ubin:** Mar 1885, *Hullett s.n.* (SING [SING0059733]); *ibid.*, 1892, *Ridley s.n.* (SING [SING0012721]); *ibid.*, Feb 1894, *Ridley 5978* (SING [SING0012720]).

5. *Dapania racemosa* Korth. (Oxalidaceae) (Fig. 7–8)

The genus *Dapania* Korth. is exceptional among other Malesian genera within the family in that it is a large liana with glabrous, exstipulate and unifoliolate leaves (Veldkamp, 1967, 1971). The leaves in *Dapania racemosa* flush pink when young but when mature they are thickly leathery, dark green above, and pale green with a yellowish tinge below. The leaf shape and size varies within a leafy branch, generally oblong to lanceolate with base cuneate to rounded to almost truncate, and apex ranging from acute to acuminate to somewhat falcate (Fig. 7). The venation of the leaves is more visible below than above with about 7 to 8 pairs of secondary veins and reticulate tertiary veins (Fig. 8–B). The petiole is articulated and the dried specimen has a distinct constriction with a groove which sometimes results in the dried leaf breaking off (Fig. 8D). This distinctive character, along with the leaf shape and venation, enables easy identification of this species even when sterile.

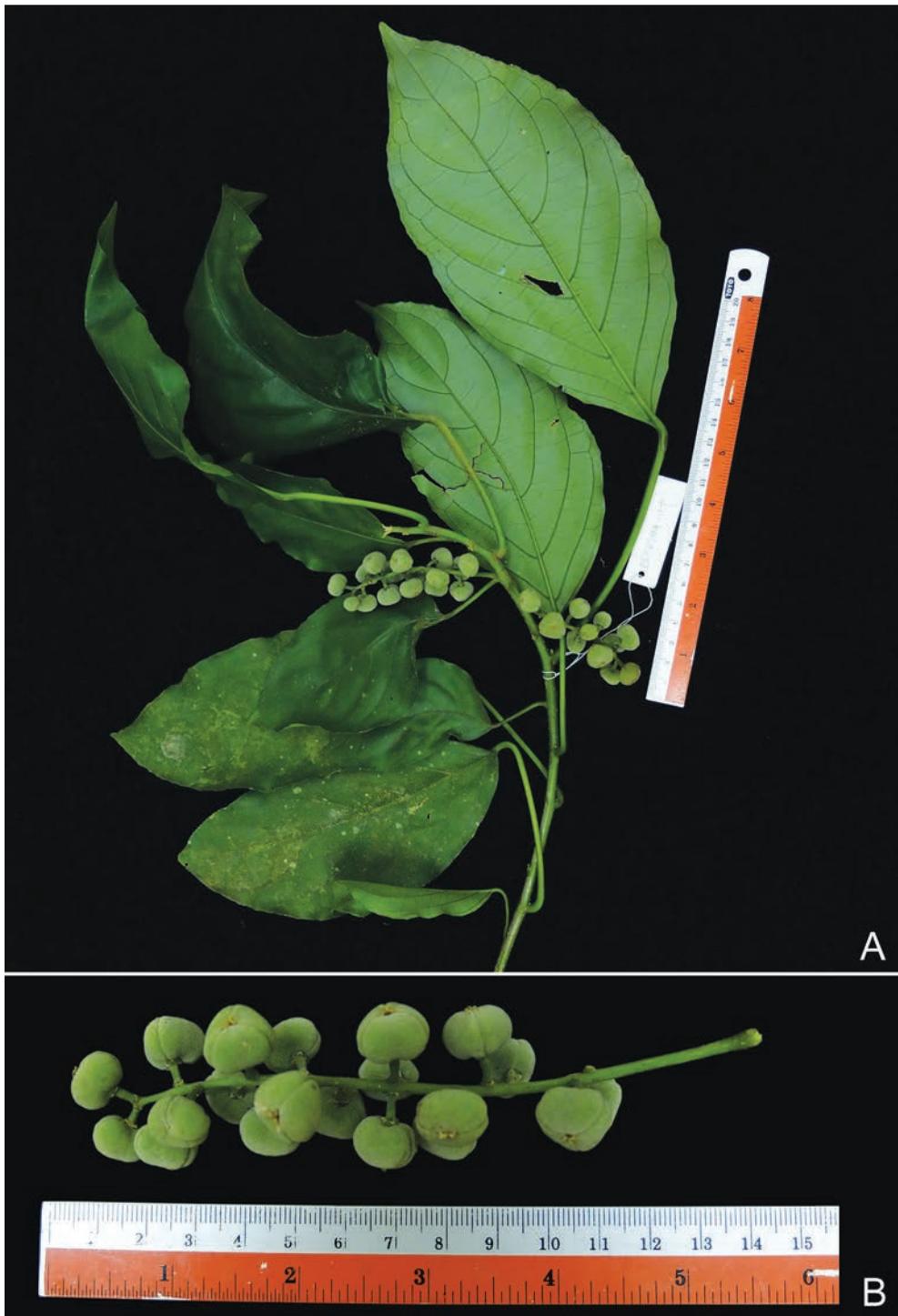


Fig. 6. *Claoxylon longifolium* (Blume) Endl. ex Hassk. **A.** Sample of a branch bearing fruits and showing the typical leaf shape. **B.** Close-up of an infructescence. All from Ho *et al.* BT2017-013. (Photos: P.K.F. Leong)



Fig. 7. Fresh specimen of *Dapania racemosa* Korth. exhibiting variation in leaf shape and size on a branch. From *Ho et al. SING 2015-129*. (Photo: P.K.F. Leong)

A plant was recently brought down by the fall of an *Oncosperma horridum* (Griff.) Scheff. on which it was climbing with its profuse branches clinging to the host palm. Some of the branches were more than 5 cm in diameter and branchlets were observed to root at nodes when in contact with the forest floor. Two sterile collections were made from different localities within BTNR to record its rediscovery in Singapore. Prior to the recent collection, the species was known from Singapore by only two previous herbarium collections deposited in SING in 1932 and 1953 from Jurong and BTNR, respectively. Only a single fertile specimen has been collected (Fig. 8C).

Specimens examined. SINGAPORE: **Jurong:** Nov 1932, *Corner s.n.* (SING [SING0014612]). **BTNR:** 27 May 1953, *Sinclair SFN39648* (SING [SING0014611]); *ibid.*, 19 May 2015, *Ho et al. SING 2015-129* (SING [SING0232275]); *ibid.*, 2 Jun 2015, *Ho et al. SING 2015-147* (SING [SING0233524]). **Nee Soon:** 7 Feb 2018, *Lua SING 2018-124* (SING, in spirit [SING0237848]).



Fig. 8. *Dapania racemosa* Korth. **A.** Leaf venation from *Curtis* 2724 (K). **B.** Leaf venation from *Ho et al.* SING 2015-129. **C.** The first fertile herbarium specimen known from Singapore: *Corner s.n.* (SING0014612). (Photos: P.K.F. Leong) **D.** Dried specimen showing constriction and articulated petiole. From *Ho et al.* SING 2015-129.

6. *Dioscorea kingii* R.Knuth (Dioscoreaceae) (Fig. 9A–D)

A rare native *Dioscorea* restricted mainly to primary forest, this climber was mentioned by Prain & Burkill (1938) as first collected in Singapore by Dr Thomas Anderson in 1861 (sterile, no detailed locality). Burkill later observed clumps growing at the edge of the Singapore Botanic Gardens jungle and off Holland Road from 1916 to 1925, but never found it in flower or in fruit (Prain & Burkill, 1938). A specimen with fruit pods was later collected by Holttum from Bukit Timah Forest in 1952, which was also the last known collection from Singapore. Ridley (1924) referred to this species as *Dioscorea porteri* Prain & Burkill and treated it as distinct from *D. kingii* (Ridley, 1925). Prain & Burkill (1938) synonymised them, with *Dioscorea kingii* having priority. However, this species has been overlooked by later authors writing on the Singapore flora and was not included in published checklists.

During the BTNR survey, a single small clump that had climbed over the understorey to about 3 metres tall was found within a primary forest habitat. The clump was not in flower or fruit, and likely too young to be of reproductive age. It was also recently collected in MacRitchie Forest with remnants of a staminate inflorescence observed on one of the plants.

This species is a shrub or moderately stout climber to 20 m in height, with the base of the stem very prickly (Fig. 9A), the spines decreasing in frequency upwards and almost absent 2 m from the base. Its leaves are simple and thinly coriaceous, narrowly lanceolate often with a cordate or auriculate base when young (15 × 3 cm) (Fig. 9B) to broadly elliptic with a rounded base (to 20 × 4.5 cm), usually opposite except for the basal leaves when young, dark green above, light green and glaucous below. The young leaves sometimes have a pale brown to purplish tinge on the leaf underside. There are 5 to 7 secondary veins, with the first two pairs of secondary veins running distinctly in a linear arrangement towards the final third of the lamina, almost equidistant from each other. Bulbils are absent. The manner in which the secondary veins diverge shortly beyond the leaf base was thought to be a good diagnostic character for the species (Prain & Burkill, 1938; Burkill, 1951), but *Dioscorea orbiculata* Hook.f. var. *tenuifolia* (Ridl.) Thapyai has a similar vein divergence. The difference in colouration of the leaf underside, particularly of the primary veins, used to distinguish the varieties *Dioscorea kingii* var. *kingii* and *D. kingii* var. *purpureovenia* (Prain & Burkill ex Ridl.) Prain & Burkill, does not appear to be consistent. Both character states have been observed on leaves within the same clump in the forest (Fig. 9C, D).

Specimens examined. SINGAPORE: **BTNR:** 19 May 1952, *Holttum s.n.* (SING [SING0066412]); *ibid.*, 1 Dec 2015, *Leong et al.* BT2015-062 (SING [SING0222235]). **MacRitchie:** 14 Oct 2014, *Leong et al.*, MR2014-059 (SING [SING0213822]); *ibid.*, 24 Jun 2015, *Lua & Nurul Huda* SING 2015-182 (SING [SING0222201, SING0214521]).



Fig. 9. *Dioscorea kingii* R.Knuth. **A.** Thorny stem base of a young plant at BTNR. **B.** Opposite leaves of a young vine, with narrowly lanceolate leaves and showing its typical venation. From *Leong et al. BT2015-062*. **C.** Leaves of a mature plant in full sun at MacRitchie forest with purple-tinged primary veins. **D.** Leaves of a mature plant in partial shade at MacRitchie forest with yellowish green primary veins. (Photos: H.K. Lua)

7. *Ficus rosulata* C.C.Berg (Moraceae) (Fig. 10A–C)

This species was collected in Singapore from Bukit Timah and Stagmont (Chua Chu Kang) between 1885 and 1928 and filed under the name *Ficus miquelii* King, which later became a synonym of *Ficus schwarzii* Koord. (Berg & Corner, 2005). However, Berg (2010) pointed out that *Ficus schwarzii* as adopted in the *Flora Malesiana* treatment (Berg & Corner, 2005) is heterogeneous. An entity that occurs from Lower Myanmar, Thailand, Sumatra, Malay Peninsula, and Borneo has been segregated under a new species *Ficus rosulata* C.C.Berg. This species differs from *Ficus schwarzii* in the absence of hairs on the inner surface of the receptacle and on the glabrous long-styled pistillate flowers (Berg, 2010).

Two specimens of *Ficus rosulata* have been recollected recently in Bukit Timah in a valley with high humidity, including one encountered during our survey. The

tree is about 8 m tall, slightly leaning towards a gap in the canopy with pale brown lenticellate but otherwise smooth and sparsely hooped bark. The twigs are reddish brown and striate, the younger region greenish and covered with brown strigillose hairs. The leaves are distichously arranged, sometimes sub-opposite, more or less obovate with a long drip tip, somewhat asymmetrically cuneate at the base, thinly coriaceous, dull mid green, sparsely pustulate above and paler green with raised midrib below. The young leaves are brownish red and the stipules are yellowish green, caducous, lanceolate with an acuminate tip. In our specimen the fig is gynodioecious with the syconium bearing long-styled pistillate florets. These are borne on cauliflorous branchlets that may be branched or not, 15 cm and more in length (Fig. 10A). The syconia are sub-globose, mid green, warty lenticillate, about 2 cm across by 1.7 cm long, ageing brown (Fig. 10B). The ostiole bracts are arranged in a rosette pointing outwards, green and triangular in shape. The pistillate flowers are pinkish red with a glabrous style (Fig. 10C).

Specimens examined. SINGAPORE: **Stagmont:** 1909, *Ridley 14142* (SING [SING0013935]). **BTNR:** 5 Apr 1885, *Hullett 448* (SING [SING0013933]); *ibid.*, 1890, *Ridley 3393* (SING [SING0013931]); *ibid.*, 1893, *Ridley 5632* (SING [SING0013936]); *ibid.*, 12 Nov 1928, *Holtum 19790* (SING [SING0013932]); *ibid.*, 13 Jul 2013, *Yeoh SING 2013-380* (SING [SING0213753]); *ibid.*, 19 Apr 2017, *Ho et al. SING 2017-136* (SING [SING0239564]).

8. *Lasianthus reticulatus* Blume (Rubiaceae) (Fig. 11A–C)

This species was first reported from Singapore in Ridley (1900) as *Lasianthus maingayi* Hook.f., now treated a synonym of *L. reticulatus* (Zhu et al., 2012), and collected several times by Ridley himself between 1890 and 1906. Subsequent collections were made in 1931 and 1982 before it was recollected again in BTNR in 2015. During the recent BTNR survey, we found this species at least four times. The Singapore specimens of this species deposited in SING were almost all collected in Bukit Timah with just a single collection from Chan Chu Kang.

This species may be characterised by a combination of different characters: medium-sized elliptic-oblong to elliptic-oblancheolate leaves, up to 26 × 9 cm, with 5–7 pairs of secondary veins and prominently scalariform-reticulate tertiary veins (Fig. 11A), densely appressed-pubescent branches and secondary veins on the lower surface, and shortly pedunculate or extremely congested cymes (Fig. 11B). *Lasianthus constrictus* Wight, with which it is most closely similar, differs in its smaller lanceolate to oblong-lanceolate leaves, up to 13 × 4 cm, with 3–5 pairs of secondary veins and faintly reticulate tertiary veins, subglabrous to sparsely strigose branches and secondary veins on the lower surface, and sessile cymes. In the Malay Peninsula, the species is better known in the literature as *Lasianthus maingayi* but it has been placed in synonymy of *Lasianthus reticulatus* following the treatment by Zhu et al. (2012).

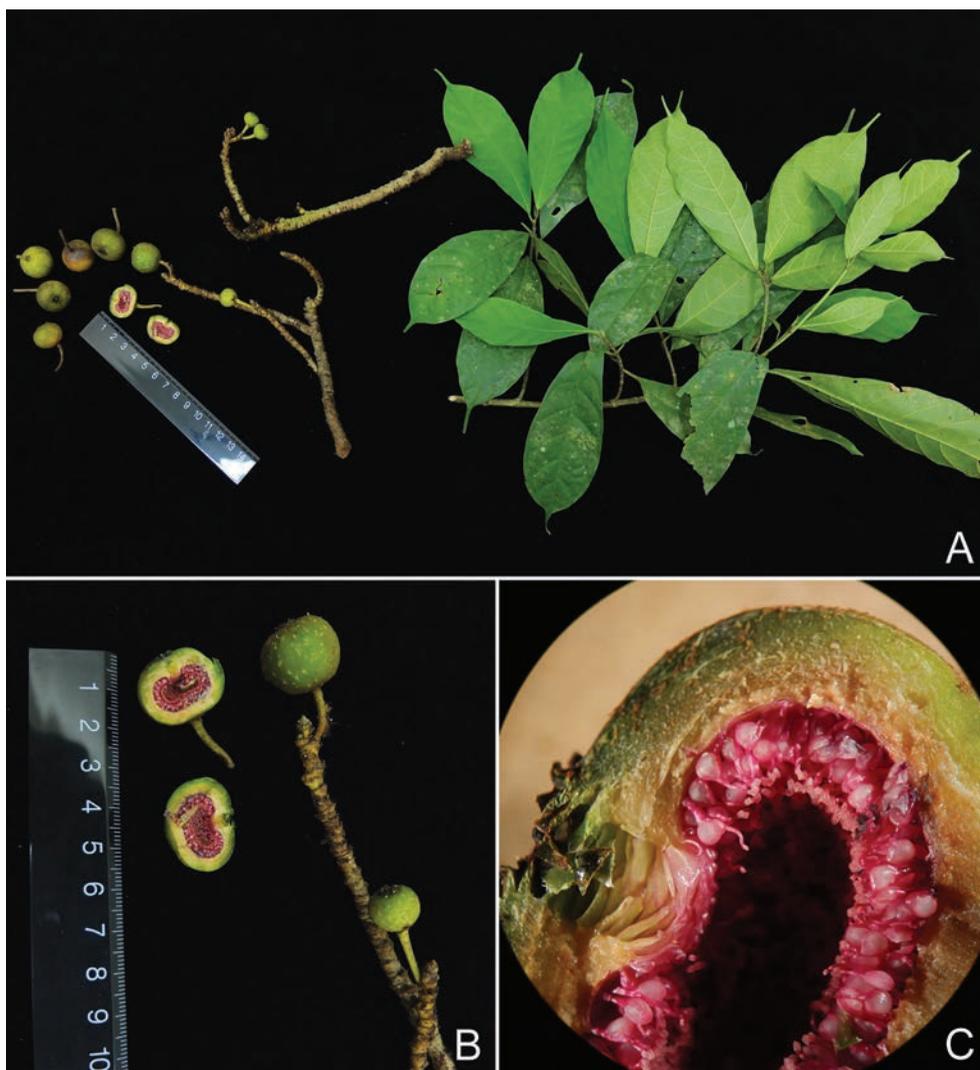


Fig. 10. *Ficus rosulata* C.C.Berg. **A.** Vegetative and cauliflorous fertile branches. **B.** Syconia. **C.** Microscopic view of the inside of syconium showing the glabrous inner receptacle wall and glabrous style. All from *Ho et al. SING 2017-136*. (Photos: P.K.F. Leong)

Specimens examined. SINGAPORE: **BTNR:** 5 Apr 1890, *Ridley s.n.* (SING [SING079386]); *ibid.*, 1894, *Ridley 6516* (SING [SING079391]); *ibid.*, Oct 1896, *Ridley s.n.* (SING [SING0172362]); *ibid.*, 1900, *Ridley 10737* (SING [SING0012087]); *ibid.*, 1906, *Ridley 12550* (SING [SING0172363]); *ibid.*, 1906, *Ridley 12553* (SING [SING0012086]); *ibid.*, 26 Feb 1931, *Mohd Nur 24640* (SING [SING0230890]); *ibid.*, 21 Oct 1982, *Maxwell 82-276* (SING [SING0012090]); *ibid.*, 6 Apr 2015, *Leong-Škorničková et al. SING 2015-103* (SING [SING0213872]); *ibid.*, 21 Mar 2017, *Ho et al. BT2017-014* (SING [SING0239380]); *ibid.*, 28 Mar 2017, *Ho et al. BT2017-015* (SING [SING0239381]); *ibid.*, 19 Apr 2017, *Ho et al. BT2017-016* (SING [SING0239382]). **Chan Chu Kang:** 1894, *Ridley s.n.* (SING [SING0012082]).

9. *Ryparosa hullettii* King (Achariaceae) (Fig. 12A–C)

This is an understory dioecious small tree or shrub that occurs in wet forests (Fig. 12A). Those found in Bukit Timah are up to 4 m tall, sometimes growing on steep slopes in filtered light to full shade. The twigs are pale brown, laxly branched and sparsely lenticillate. The leaves are without stipules, glabrous, thinly coriaceous, elliptic to obovate, dull dark green above, sub-glaucous green below, about 4 pairs of secondary veins, with a 3.5 cm long petiole, swollen at both ends. The inflorescence is a raceme, arising from bare twigs below leaves or on the stem between twigs, sometimes singly or two to three together from an axil. Specimens collected from Singapore either bear staminate inflorescences or pistillate infructescences with fruits only. No specimens bearing pistillate inflorescences have been collected. Staminate inflorescences can reach up to 50 cm or more long and are pendent and pale green with about 30 flowers per inflorescence (Fig. 12B). The floral bract is small, green turning brown, subulate and sub-persistent. The staminate flower is small, about 9 mm high by 4 mm diameter with a 2 mm long pedicel. The calyx is green, glabrous inside and hairy on the outside, three lobed, ovate and reflexed. The petals are pale green, five, ovate, each with a scale about half its length at the base. The five ochre stamens are connate to form a column. The infructescence is short, to about 6 cm long (herbarium specimens) with up to eight fruits (Fig. 12C). The unripe fruit is green, about 7 × 4 cm. The characters conform to the description given by Sleumer (1954).

This species was collected from BTNR, Chan Chu Kang and Sungei Buloh between the 1890s and 1938 and was considered nationally extinct in Singapore (Tan et al., 2008). It was recollected in 2013 from BTNR and all the subsequent collections are from the same nature reserve.

Specimens examined. SINGAPORE: **Sungei Buloh:** Apr 1894, *Mats.n.* (SING [SING0017546]). **BTNR:** Oct 1885, *Hullett 872* (isotype SING [SING0054356]); *ibid.*, 28 Nov 1938, *Ngadiman SF35947* (SING [SING0017541, SING0017542, SING0017548]); *ibid.*, 13 Jul 2013, *Yeoh SING 2013-379* (SING [SING0212352]); *ibid.*, 3 Jul 2014, *Lua et al. SING 2014-313* (SING [SING0213527]); *ibid.*, 6 Apr 2015, *Leong-Škormičková et al. SING 2015-098* (SING [SING0213868]); *ibid.*, 22 Apr 2015, *Ho et al. BT2015-001* (SING [SING0239577]); *ibid.*, 19 Apr 2017, *Ho et al. SING 2017-143* (SING [SING0239565]). **Chan Chu Kang:** 1894, *Mat 6754* (SING [SING0017547]).

10. *Senegalia kekapur* (I.C.Nielsen) Maslin, Seigler & Ebinger (Fabaceae) (Fig. 13A–B)

Specimens of this species, all in flower, were first collected in the late 1800s from Changi and Bukit Timah but were referred to *Acacia pseudointsia* Miq. The species *Senegalia kekapur* was recognised and described much later by Nielsen (1985) as *Acacia kekapur* I.C.Nielsen and all historical specimens from Singapore were segregated from *A. pseudointsia* into *A. kekapur*. The genus *Acacia* Mill. has proven to be heterogeneous and this species belongs to *Senegalia* Raf., one of its segregates.

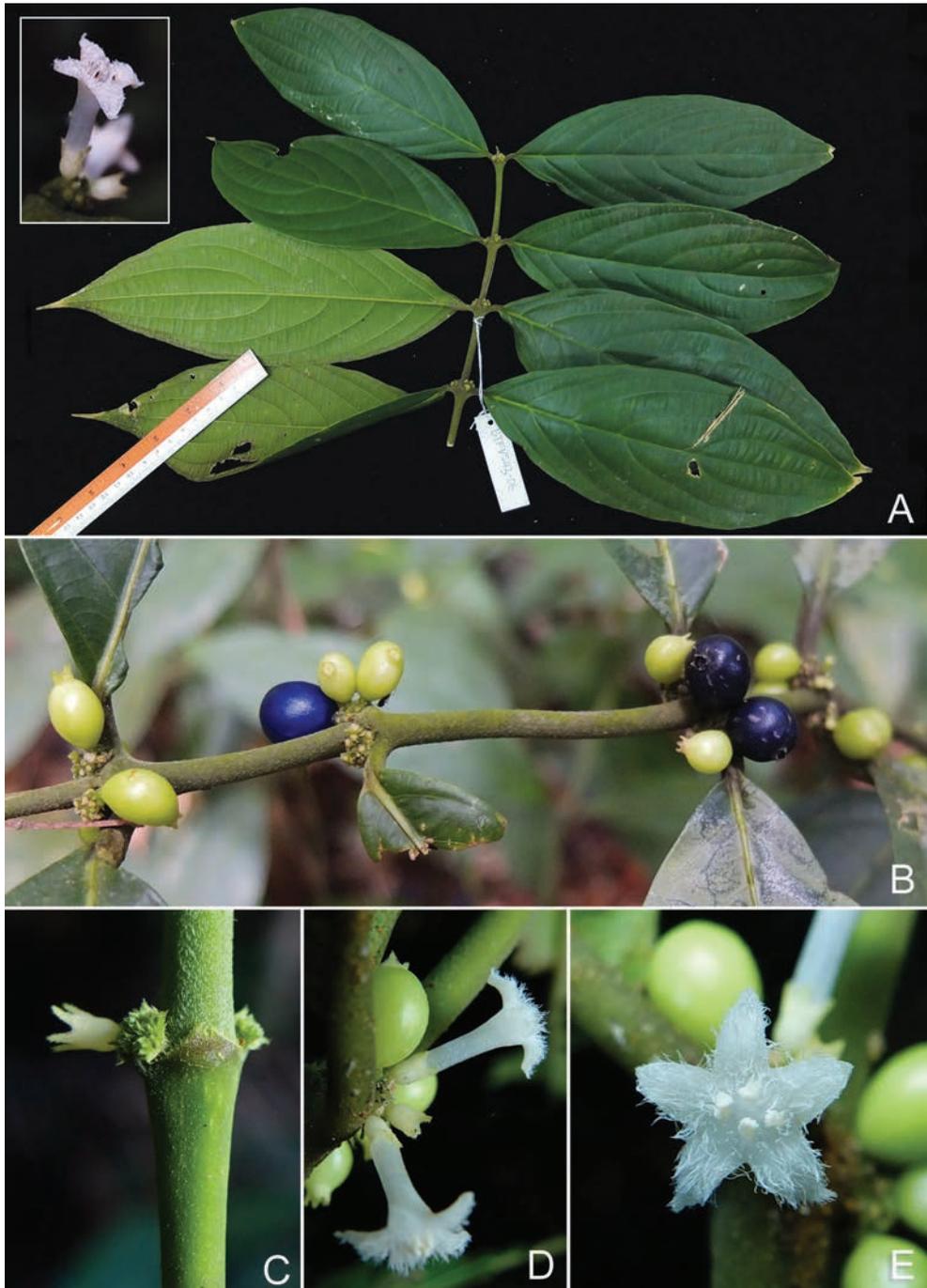


Fig. 11. *Lasianthus reticulatus* Blume. **A.** Fresh specimen exhibiting the prominently scalariform-reticulate tertiary veins (Inset: detail of a typical tetramerous flower). **B.** Field picture of the condensed infructescences. **C.** Detail of stipule. **D.** Detail of flower from side view. **E.** Detail of flower from front view (note presence of an aberrant fifth petal which occasionally occur on this species). A & B from *Ho et al. BT2017-015*; C–E from *Leong-Škorničková et al. SING 2015-103*. (Photos: A & B, P.K.F. Leong; C–E, J. Leong-Škorničková)

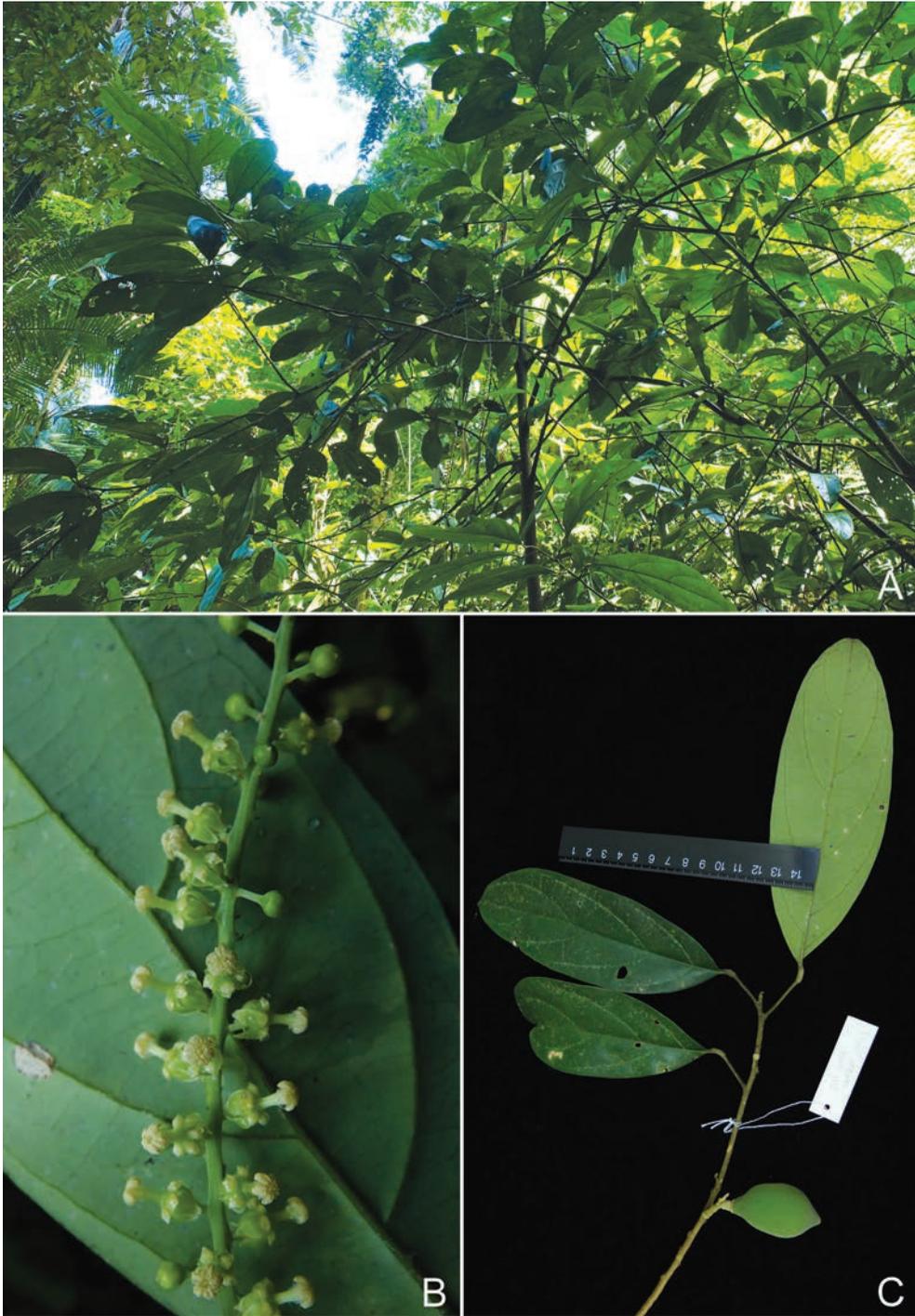


Fig. 12. *Ryparosa hullettii* King. **A.** Habit of the small tree or shrub. From BTNR. **B.** Staminate inflorescence. From Leong-Škorničková *et al.* SING 2015-098. **C.** Infructescence with a fruit (could be up to 8 fruits per infructescence). From Ho *et al.* BT2015-001. (Photos: A & B, J. Leong-Škorničková; C, P.K.F. Leong)



Fig. 13. *Senegalia kekapur* (I.C.Nielsen) Maslin, Seigler & Ebinger **A.** A branch showing the prickles, stem tendrils and bipinnate compound leaves. From *Ali Ibrahim & Koh PU2014-018*. **B.** A fresh petiole gland, raised in the distal portion. From *Maslin et al. BRM11001*. (Photos: A, B.C. Ho; B, B.R. Maslin)

Senegalia is distinct among other segregates of *Acacia* by the combination of having bipinnate leaves and stems bearing prickles. In addition, almost all members of *Senegalia* are woody lianas (Maslin, 2015 and references therein).

Nielsen (1985), when describing *Acacia kekapur*, even suggested that the specimens from Singapore might represent a distinct taxon when fruiting material is known. Unfortunately no specimens were collected after 1894 and it was previously considered nationally extinct (Tan et al., 2008). A population of the species was discovered fairly recently on Pulau Ubin and has been collected a few times. A collection was also made from Mandai in 2014. During our survey in BTNR, we have observed a few stands within and around the nature reserve while vouchers have been made from two of them.

Senegalia kekapur is characterised by rather large leaflets (7–16 × 1–3 mm) which are unequally lobed at the base and with an excentric petiolule, and by the striate and densely hairy stem that may become glabrescent when older (Fig. 13A). The petiole gland, which is situated just above the base of the pulvinus, is also exceptional in that it is often raised in the distal portion (Fig. 13B) (Nielsen, 1985).

Specimens examined. SINGAPORE: **BTNR:** Apr 1894, *Mat 6177* (SING [SING0018279]); *ibid.*, 19 Jan 2016, *Ho et al. SING 2016-010* (SING [SING0239371, SING0239372]); *ibid.*, 16 Mar 2016, *Lua SING 2016-252* (SING [SING0239373]). **Mandai:** 1890, *Ridley s.n.* (SING [SING0018275]); *ibid.*, 23 Oct 2014, *Maslin et al. BRM11001* (SING [SING0208531, SING 0208532]). **Changi:** Mar 1885, *Hullett 458* (SING [SING0018278]); 1892, *Ridley 3631a*

(SING [SING0018276]). **Pulau Ubin**: 2 Oct 2012, *Lai & Ali Ibrahim SING 2012-468* (SING [SING0185178]); *ibid.*, 8 Dec 2014, *Ali Ibrahim & Koh PU2014-018* (SING [SING0208543]); *ibid.*, 12 Feb 2015, *Maslin et al. BRM11004* (SING [SING0208536, SING0208537, SING0208538]), *BRM11005* (SING [SING0208539, SING0208540]).

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References

- Ahmad Sofiman, O., Boyce, P.C. & Chan, L.K. (2010). Studies on Monstereae (Araceae) of Peninsular Malaysia III: *Scindapsus lucens*, a new record for Malaysia, and a key to Peninsular Malaysian *Scindapsus*. *Gard. Bull. Singapore* 62(1): 9–15.
- Berg, C.C. (2010). Redefinition of *Ficus schwarzii* and two new species of *Ficus* (Moraceae). *Blumea* 55: 115–117.
- Berg, C.C. & Corner, E.J.H. (2005). Moraceae — *Ficus*. *Flora Malesiana*, ser. 1, Seed Plants, vol. 17, part 2. Leiden: Foundation Flora Malesiana.
- Bogner, J. & Boyce, P.C. (1994). *Scindapsus lucens* (Araceae: Monsteroideae), a new species related to *Scindapsus pictus*. *Kew Bull.* 49(4): 789–792.
- Burkill, I.H. (1951) Dioscoreaceae. In: Van Steenis, C.G.G.J. (ed.) *Flora Malesiana*, ser. 1, Seed Plants, vol. 4, part 3, pp. 293–335. Leiden: Noordhoff.
- Chin, S.C., Corlett, R.T., Wee, Y.C. & Geh, S.Y. (eds) (1995) *Rain forest in the city: Bukit Timah Nature Reserve Singapore*. *Gard. Bull. Singapore* Suppl. 3. Singapore: National Parks Board, Singapore.
- Chong, K.Y., Tan, H.T.W. & Corlett, R.T. (2009). *A Checklist of the Total Vascular Plant Flora of Singapore — native, naturalised and cultivated species*. Singapore: Raffles Museum of Biodiversity Research, National University of Singapore.
- Davison, G.W.H., Ng, P.K.L. & Ho, H.C. (eds) (2008). *The Singapore Red Data Book: Threatened Plants & Animals of Singapore*, 2nd ed. Singapore: The Nature Society (Singapore).
- Dransfield, J. (1979). *A manual of the rattans of the Malay Peninsula*. *Malayan Forest Records* no. 29. Kuala Lumpur: Forest Department, Ministry of Primary Industries Malaysia.
- Furtado, C.X. (1956). Palmae Malesicae, XIX — The genus *Calamus* in the Malayan Peninsula. *Gard. Bull. Straits Settle.* 15: 32–265.

- Holttum, R.E. (1955 [‘1954’]). *Ferns of Malaya. A Revised Flora of Malaya*, vol. 2. Singapore: Government Printing Office.
- Holttum, R.E. (1968). *Ferns of Malaya. A Revised Flora of Malaya*, vol. 2, ed. 2. Singapore: Government Printing Office.
- Killip, E.P. (1938). The American species of Passifloraceae. *Publ. Field Mus. Nat. Hist., Bot. Ser.* 19: 1–613.
- Maslin, B.R. (2015). Synoptic overview of *Acacia sensu lato* (Leguminosae: Mimosoideae) in East and Southeast Asia. *Gard. Bull. Singapore* 67(1): 231–250.
- Nielsen, I.C. (1985). The Malesian species of *Acacia* and *Albizia* (Leguminosae-Mimosoideae). *Opera Bot.* 81: 1–50.
- Pannell, C.M. (1989). *Aglaia* Lour. In: Ng, F.S.P. (ed.) *Tree Flora of Malaya*, vol. 4, pp. 207–230. Malaysia: Forest Research Institute Malaysia.
- Pannell, C.M. (1992). *A taxonomic monograph of the genus Aglaia Lour. (Meliaceae)*. *Kew Bull., Addit. Ser.*, vol. 16. United Kingdom: Royal Botanic Gardens, Kew.
- Pannell, C.M. (2013). *Aglaia* Lour. In: Kiew, R., Chung, R.C.K., Saw, L.G. & Soepadmo, E. (eds) *Flora of Peninsular Malaysia*, ser. II, Seed Plants, vol. 4, pp. 54–155. Malaysia: Forest Research Institute Malaysia.
- Prain, D. & Burkill, I.H. (1938). An account of the genus *Dioscorea* in the East, Part 2. The species which twine to the right: with addenda to Part 1 and a summary. *Ann. Roy. Bot. Gard. (Calcutta)* 14(2): 211–528.
- Ridley, H.N. (1900). The flora of Singapore. *J. Straits Branch Roy. Asiat. Soc.* 33: 27–196.
- Ridley, H.N. (1924). *Flora of the Malay Peninsula*, vol. IV. London: L. Reeve & Co. Ltd.
- Ridley, H.N. (1925). *Flora of the Malay Peninsula*, vol. V. London: L. Reeve & Co. Ltd.
- Sleumer, H. (1954). Flacourtiaceae. In: Van Steenis, C.G.G.J. (ed.) *Flora Malesiana*, ser. 1, Seed Plants, vol. 5, part 1, pp. 1–106. Leiden: Noordhoff.
- Tan, B.C. & Ng, A. (2012). 3 new records of little-known Singapore ferns. *Nature Watch* 20(3): 2–7.
- Tan, H.T.W., Tan, K.-X., Ali Ibrahim, Chew, P.T., Chua, K.S., Duistermaat, H., Ganesan, S.K., Goh, M.W.K., Gwee, A.T., Kiew, R., et al. (2008). Seed Plants. In: Davison, G.W.H., Ng, P.K.L. & Ho, H.C. (eds) *The Singapore Red Data Book — Threatened Plants & Animals of Singapore*, ed. 2, pp. 213–245. Singapore: The Nature Society (Singapore).
- Turner, I.M. & Chua, K.S. (2011). *Checklist of the vascular plant species of the Bukit Timah Nature Reserve*. Singapore: Raffles Museum of Biodiversity Research, National University of Singapore.
- Van Welzen, P.C. (2017). *Claoxylon*. In: Van Welzen, P.C. & Chayamarit, K. *Flora of Thailand Euphorbiaceae*. Naturalis Biodiversity Center, Leiden, and Forest Herbarium, National Park, Wildlife and Plant Conservation Department, Bangkok. www.nationaalherbarium.nl/thaieuph. Accessed 12 Jan. 2018.
- Veldkamp, J.F. (1967). A revision of *Sarcotheca* Bl. and *Dapania* Korth. (Oxalidaceae). *Blumea* 15(2): 519–543.
- Veldkamp, J.F. (1971). Oxalidaceae. In: Van Steenis, C.G.G.J. (ed.) *Flora Malesiana*, ser. 1, Seed Plants, vol. 7, part 1, pp. 151–178. Leiden: Noordhoff.
- Zhu, H., Roos, M.C. & Ridsdale, C.E. (2012). A taxonomic revision of the Malesian species of *Lasianthus* (Rubiaceae). *Blumea* 57: 1–102.