

Additions to the Flora of Singapore: New and overlooked records of naturalised plant species (4)

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Abstract. Three non-native plant species, *Cassia fistula* L. (Fabaceae), *Fatoua villosa* (Thunb.) Nakai (Moraceae) and *Tabernaemontana africana* Hook. (Apocynaceae: Rauvolfioideae) are new records of spontaneously occurring non-native plants in Singapore. *Fatoua* Gaudich. is a new generic record for the Flora of Singapore.

Key words. casual, naturalised species, new generic record, new species records

INTRODUCTION

This paper belongs to a series dealing with the casual and naturalised flora of Singapore to better document its diversity with proper specimen records. Twenty-one species have so far been added to the list of non-indigenous species for Singapore in the first three parts of this series (Chen et al., 2018a; Chen et al., 2018b; Chen et al., 2020). In the fourth part of this series, three more species, inclusive of one new genus, are reported here as part of this ongoing project. A brief description is provided for each new record based on the respective cited specimens studied. Specimens are deposited in the herbarium of the Singapore Botanic Gardens (SING).

NEW RECORDS OF NATURALISED SINGAPORE PLANTS

1. *Cassia fistula* L., Sp. Pl. 1 (1753) 377 (Fabaceae) (Fig. 1)

Description. Woody seedling to 50 cm tall. Stem terete and dark brown when dry, sparsely pubescent with short white adpressed hairs. Leaves alternate, compound, paripinnate; stipules deltoid with an acute tip, 1–1.5 mm long, late caducous, pubescent at the tip; petiole terete when dry, sparsely pubescent, 3.2–7 cm long; rachis terete, sparsely pubescent, 6.6–14.5 cm long; petiolules 4–6 mm, densely fissured and puberulous; leaflets 3–4 pairs, opposite, subcoriaceous, ovate, 5.2–12.5 × 3.3–6.8 cm, base obtuse, apex acute; upper surface green, shining and minutely puberulous, midrib sunken; lower surface pale green dull, not shining, tinged with maroon at the midribs when dry, minutely puberulous and midrib strongly raised.

The description is made from seedlings under a mature *Cassia fistula* tree, which was observed to be fruiting at the time of collection. The stipule and leaflet characters also match the description from Larsen & Hou (1996). For a full description on the adult tree, see Larsen & Hou (1996).

Distribution. The species is the national tree of Thailand and has been presumed to be native to India, Sri Lanka, Myanmar, Northern Thailand and possibly eastern Malesia (Maluku Islands, Lesser Sunda Islands and parts of Sulawesi), which all share a seasonal monsoon climate with a pronounced dry season (de Wit, 1955). *Cassia fistula* is now known to be widespread across the tropics and has been introduced to the Malay Peninsula, Philippines, China and Egypt as an ornamental tree (Larsen & Hou, 1996). Elsewhere, the species has been reported to have been established in the West Indies and Mexico prior to the 1800s, and be widely planted in parts of South America, from which they are sometimes known to be “sparingly spontaneous but nowhere extensively naturalised or appearing native” (Irwin & Barneby, 1982).

Occurrence in Singapore. The species has been planted in many locations around Singapore, such as in parks and along traffic expressways, as an ornamental tree (National Parks Board, 2001; Chen et al., 2015) because of its bright yellow flowers.



Fig. 1. *Cassia fistula* L. A, mature trees (pointed out in red arrows) under which the seedlings were found; B, C, seedlings (pointed out in yellow arrows). A, B from L.M.J. Chen LCMJ 2020-050. (Photographs by: L. M. J. Chen).

Local status. Casual—*Cassia fistula* is listed as “Cultivated Only” in Singapore by Chong et al. (2009). The species is also not native to the Malay Peninsula (Prain, 1897; Ridley, 1922; Corner, 1940; Larsen & Hou, 1996). However, even with widespread planting and intermittent frequent fruiting of *Cassia fistula* trees throughout the year (de Wit, 1955), there has been no record of this species appearing spontaneously until now. We think that this could be possibly due to the ‘suitability’ of the areas in which the species has been planted, as our records of regeneration of this species are from parks, instead of green verges along pedestrian paths or along expressways. The planting of the trees in parkland could have benefitted the species, as the seeds fall on arable ground, and seedlings are more likely to be able to persist since there are less intensive land management activities around adult trees, whereas seedlings in intensively managed green areas would have been promptly removed by park authorities. Another likely reason the regeneration has not been recorded until now could be the lack of documentation of escaped or casual species among common parkland or streetscape vegetation.

Ecology. The green pods of *Cassia fistula* are known to be eaten by Tanimbar corellas (*Cacatua goffini*), an escaped cage-bird species in Singapore (Bird Ecology Study Group, 2009). It is not known if the corellas are effective dispersal agents as the seeds released from the pod may not be of sufficient maturity for germination. The pods are indehiscent, and they have not been observed to be dispersed by any native animals (Bird Ecology Study Group, 2009).

Specimens examined. SINGAPORE: Kallang Riverside Park, 7 February 2020, L.M.J. Chen LCMJ2020-050 (SING, 2 sheets).

**2. *Fatoua villosa* (Thunb.) Nakai, Bot. Mag. (Tokyo) 41 (1927) 516 (Moraceae)
(Fig. 2)**

Description. Erect, branched herb to 50 cm tall, sometimes scrambling, sap watery; roots mustard yellow. Twigs densely pubescent. Leaves alternate, simple; stipules 1.5–2 mm, pubescent, usually persistent; petiole 0.5–1.8 cm, pubescent; lamina ovate to cordate, 0.9–4.5 × 0.6–3.3 cm, chartaceous, base cordate to truncate and not decurrent on petiole, margin serrate to crenate, apex acuminate; pinnately veined at the base, secondary venation 5–7 pairs, craspedodromous, tertiary venation scalariform to reticulate; upper surface pubescent with hispid hairs, sunken midrib with short incurved hairs especially at the base; lower surface puberulous especially on the midrib and venations. Pubescent on twigs and lower leaf surfaces with short incurved or hooked hairs interspersed with longer hooked ones. Inflorescences axillary, compacted cymose, emerging solitary or in pairs, 8–12 × 4–7 mm, peduncle 8.5–11 mm long, minutely puberulous. Bracts numerous within an inflorescence, narrowly lanceolate and pubescent, c. 1 mm, green. Staminate and pistillate flowers up to about 30 mixed in the same inflorescence. Staminate flowers shortly pedicellate, campanulate; calyx 4, triangular and boat-shaped, c. 1 × 0.5 mm, outer surface pubescent with the same type of hairs as the twigs and leaves, inner surface glabrous; anthers 4, exerted from flower when mature, filaments c. 1.2 mm, white, anthers globose, c. 0.5 mm, white; pistillode conical. Pistillate flowers sessile, obovate; calyx 4, lanceolate, c. 1 mm long, pubescent with the same type of hairs as the twigs and leaves, ovary globose, c. 0.5 mm long, style emerging laterally, c. 2.4 mm long. Fruit achene-like with persistent enlarged perianth, at maturity dehiscent from the rest of the infructescence, white darkening to dull ochre, exposing the ridged and bumpy endocarp surface. Seed 1 per fruit, compressed 3-angled, c. 1 mm long.

Taxonomic notes. Wu et al. (2003) accepted two species of *Fatoua* in China, in which *Fatoua villosa*, also known as the mulberry weed or hairy crabweed, is distinguished by characters including an annual habit, puberulous petiole, membranous leaf blade and decurrent leaf base; *Fatoua pilosa* has a perennial habit, spreading petiole hairs, papery leaf blade and a non-decurrent leaf base. However, Berg et al. (2006) placed *Fatoua pilosa* under the synonymy of *Fatoua villosa*, stating that it is not clear that the plants in Malesia have an annual or perennial character, and that while the species is very variable in terms of habit, indumentum and leaf characters, varieties cannot be clearly separated. Following the account of Wu et al. (2003), our specimens fit the leaf description of *Fatoua pilosa* better with its lack of decurrent leaf bases. However, the petiole indumentum, which we observe to be “pubescent with small incurved hairs interspersed with longer hooked hairs,” does not appear to match the description of either *Fatoua pilosa* or *Fatoua villosa*. The populations in Singapore also do not appear to behave as annuals. As such, we agree with the description and treatment in Berg et al. (2006) and treat our species as *Fatoua villosa*.

Distribution. *Fatoua villosa* is widespread across Asia, with records from China, Japan, Indochina, Australia, the Solomon Islands and New Caledonia. In Malesia, the species is distributed in the Philippines and parts of Indonesia such as Java, Lesser Sunda Islands, Sulawesi, Moluccas and New Guinea. The species has also been reported to be naturalised in Hawaii (Imada, 2012), continental United States and Bahamas (Wunderlin, 1997), and Puerto Rico (Liogier & Martorell, 2000).

Occurrence in Singapore. The species has been found in several localities with open habitats, such as wastelands, canal walls and embankments as well as surface car parks.

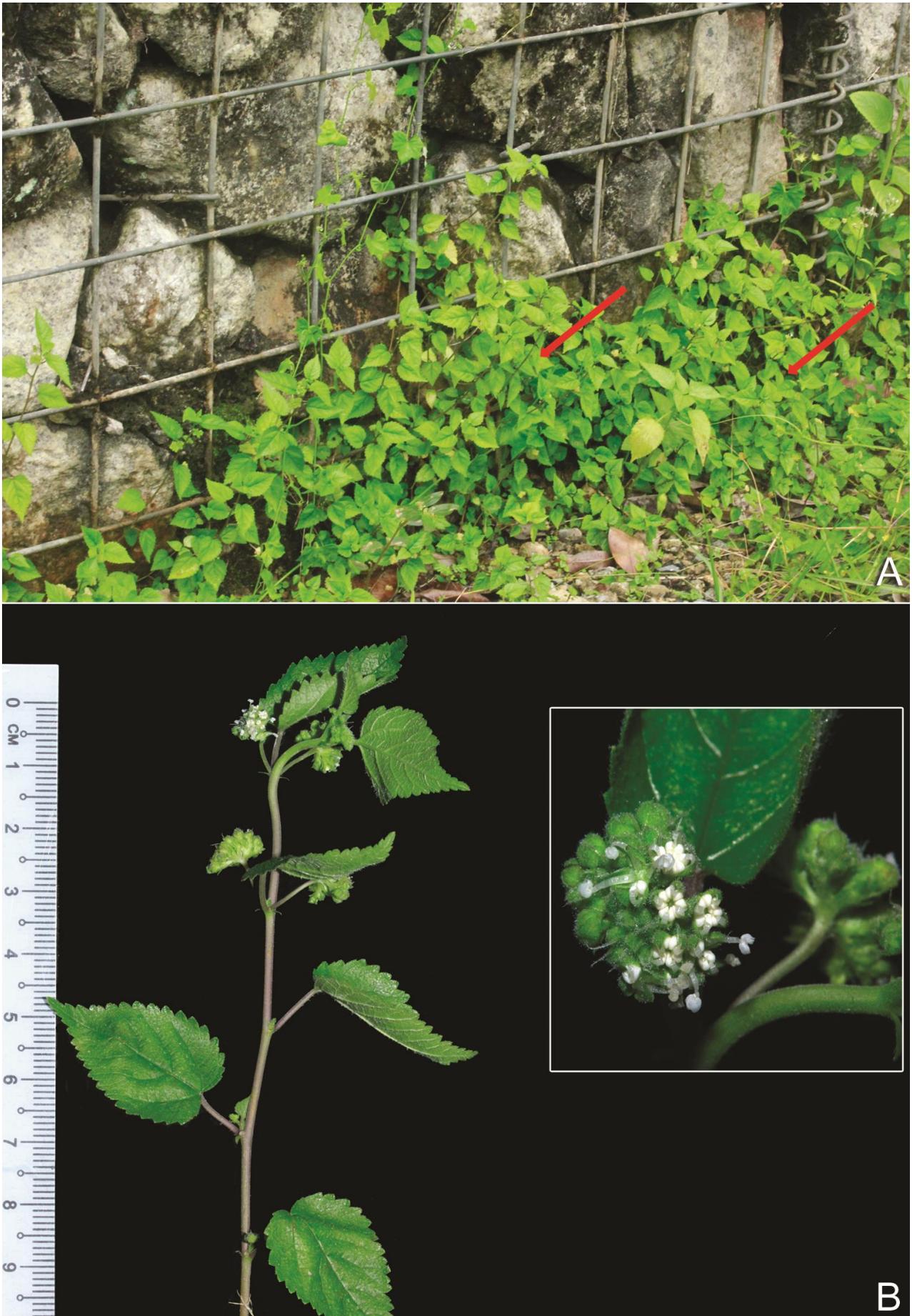


Fig. 2. *Fatoua villosa* (Thunb.) Nakai. A, *Fatoua villosa* plants (pointed out in red arrows) growing among a rock embankment at Bishan-Ang Mo Kio Park; B, mature plant with inflorescences, inset showing the male and female flowers within the inflorescences. A from L.M.J Chen SING 2017-756; B, C from L.M.J. Chen LCMJ 2020-007. (Photographs by: L. M. J. Chen).

Local status. Naturalised—the species was first photographed by K. H. Ong in June 2015 (Ong, 2015), and the images are a good match, but no specimens were made. Here we formally record the presence of *Fatoua villosa* as a naturalised species in Singapore. At the same time, this represents the first record of the genus *Fatoua* for the Flora of Singapore. It is tolerant of dry conditions with the potential to form large patches of 50 individuals or more, a sign of successful naturalisation.

Specimens examined. SINGAPORE: Bishan-Ang Mo Kio Park, 12 December 2017, L.M.J. Chen SING2017-756 (SING, 2 sheets); Pasir Panjang Road, 6 March 2018, L.M.J. Chen SING2018-248 (SING, 2 sheets); Bartley Road, 13 January 2020, L.M.J. Chen LCMJ2020-007 (SING, 2 sheets); Sin Ming Avenue, 22 May 2020, L.M.J. Chen LCMJ2020-150 (SING), 22 May 2020, L.M.J. Chen LCMJ2020-151 (SING).

3. *Tabernaemontana africana* Hook., Trav. West. Afr. (1825) 389 (Apocynaceae: Rauvolfioideae) (Fig. 3)

Description. Large shrub 5–6 m tall, dbh 10 cm. Branchlets glabrous, lenticellate and ringed with old leaf scars. Leaves opposite, with colleters in the leaf axils; petiole 4–13 mm; leaf lamina simple, elliptic, (3.3–)6.3–13.5 × (1.4–)2.6–4.2 cm, 2.3–3.2 times as long as wide, base cuneate, apex acuminate, smoothly coriaceous, secondary veins 6–10 pairs, tertiary venation indistinct, glabrous above and below. Inflorescence 1–2-flowered, glabrous, pedicels 8–11 mm. Calyx 5-lobed, lobes ovate, 7–7.2 × 3.6–4 mm, margins ciliate, apex obtuse, surface glabrous. Corolla sympetalous, 5-lobed, sinistrose, creamy white blending into egg-yellow at the centre of the corolla in open flowers, mature buds 6.7–7 cm long with a subglobose head 6–8 mm long, apex rounded; tube 6.1–7.3 cm; lobes 4.5–5 × 1–1.2 cm, apex rounded; outer surface of tube glabrous but pubescent at base and margins of lobes, inner surface of tube pubescent with villose hairs, lobes pubescent with short hairs from lower half to the rim of the top of the tube. Stamens 5, inserted in the lower third of the tube, anthers 1.35–1.4 × 2.4–2.6 mm. Pistil 1, glabrous; ovary ovoid, c. 5.5 × 2.5 mm, with a 2-mm tall disk at the base; style glabrous, c. 1.8 mm long in bud, style head c. 5 × 3 mm in bud, flared at the base. Fruit dehiscent, consisting of two follicles joined at the base; follicle ovoid, green (unripe), 3.5–4.2 × 3–3.2 × 2.5–2.8 cm, surface smooth glossy. Seeds numerous, with an orange-red aril.

Distribution. *Tabernaemontana africana*, which is also known as the Samoan gardenia, is native to West Tropical Africa from Senegal to Ghana (Leeuwenberg, 1991), but is known to be cultivated for its large scented flowers (Burkill, 1985).

Occurrence in Singapore. The species in Singapore is currently known from two trees in Coney Island. The trees are reported to have been present well before the development of Coney Island into a public nature area by the National Parks Board (Neo M.Y., pers. comm.). Coney Island was subject to active human disturbance from the 1930s onwards, first as land owned by the Haw Par Brothers from the 1930s to 1940s, where they built a bungalow called the Haw Par Beach Villa. In 1950, the island was sold to a businessman who developed the island into a leisure resort. Over the next 25 years, the island changed hands several times, until the government acquired it from a Thai businessman in 1975. Reclamation works on the island happened twice, in 1975 and the 1990s, after which, not much activity happened until Coney Island's redevelopment and opening as a public park in 2015 (Lim, 2016). The trees are likely remnants from the previous land use of the island anytime from the 1930s until the National Parks Board took over the development of the island in the early 2010s.

Local status. Casual; as a remnant of former cultivation—the species is native to Africa but is known to be planted in Singapore for ornamental purposes (Chen et al., 2015). The presence of two plants in a previously non-managed area in Singapore shows that they are likely remnants persisting from former cultivation. It is not known if these are the same trees that were originally planted, or if they were descendants of the previously cultivated trees on Coney Island, since we did not observe any seedlings or saplings even though the two trees were clearly producing fruits and seeds. Further observations will be required to see if the species will reproduce successfully and naturalise in due course.

Specimens examined. SINGAPORE: Coney Island, 6 March 2019, L.M.J. Chen, W.H. Lim, S.L. Koh, D. Liew & M.Y. Neo LCMJ2019-107 (SING, 2 sheets).



Fig. 3. *Tabernaemontana africana* Hook. (pointed out in yellow arrow) from Coney Island. A, *Tabernaemontana africana* growing as a dense shrub; B, flowers, inset showing the unripe fruits. A–B from L.M.J. Chen, Lim W.H., Koh S.L., Liew D. & Neo M.Y. LCMJ 2019-107. (Photographs by: L. M. J. Chen).

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LITERATURE CITED

- Berg CC, Corner EJH & Jarrett FM (2006) *Fatoua*. In: Berg CC, Corner EJH & Jarrett FM (eds.) *Moraceae (genera other than Ficus)*. Flora Malesiana. Series I, Volume 17, Part 1. Nationaal Herbarium Nederland, Leiden, pp. 33–35.
- Bird Ecology Study Group (2009) Tanimbar Corella Eating Cassia Fruit. <https://besgroup.org/2009/02/16/tanimbar-corella-eating-cassis-fruit/> (Accessed 17 March 2020).
- Burkill HM (1985) *The Useful Plants of West Tropical Africa*. Volume 1. Families A–D. Royal Botanic Gardens, Kew, 960 pp.
- Chen L, Ang WF, Ng A, Teo J & Tang J (2015) *1001 Garden Plants in Singapore*. 3rd Edition. National Parks Board, Singapore, 810 pp.
- Chen LMJ, Ho BC, Choo LM & Koh SL (2018a) Additions to the Flora of Singapore, new and overlooked records of naturalised plant species (1). *Gardens' Bulletin Singapore*, 70: 91–101.
- Chen LMJ, Lua HK, Yeo RSW, Choo LM, Ho BC, Chua KS & Koh SL (2018b) Additions to the flora of Singapore — new and overlooked records of naturalised plant species (2). *Nature in Singapore*, 11: 63–75.
- Chen LMJ, Lua HK, Yeo RSW, Choo LM, Lim WH, Athen P, Chua KS, Koh SL & Ho BC (2020) Additions to the Flora of Singapore: New and overlooked records of exotic plant species (3). *Nature in Singapore*, 13: 27–37.
- Chong KY, Tan HTW & Corlett RT (2009) *A Checklist of the Total Vascular Plant Flora of Singapore: Native, Naturalised and Cultivated Species*. Raffles Museum of Biodiversity Research, National University of Singapore, Singapore, 273 pp. Uploaded 12 November 2009. https://lkcnhm.nus.edu.sg/app/uploads/2017/04/flora_of_singapore_tc.pdf (Accessed 14 January 2020).
- Corner EJH (1940) *Wayside Trees of Malaya*. 1st Edition. Volume 1. Government Printing Office, Singapore, vii + 770 pp.
- de Wit HCD (1955) A revision of the genus *Cassia* (Caesalp.) as occurring in Malaysia. *Webbia*, 11: 197–292.
- Imada C (2012) *Hawaiian Native and Naturalized Vascular Plants Checklist (December 2012 Update)*. Bishop Museum Technical Report 60. Bishop Museum, Hawaii, 380 pp.
- Irwin HS & Barneby RC (1982) The American Cassiinae: A synoptical revision of Leguminosae tribe Cassieae subtribe Cassinae in the new world. *Memoirs of the New York Botanical Garden*, 35: 1–918.
- Larsen K & Hou D (1996) *Cassia*. In: Hou D, Larsen K & Larsen SS (eds.) *Caesalpiniaceae*. Flora Malesiana. Series I, Volume 12. Nationaal Herbarium Nederland, Leiden, pp. 556–565.
- Leeuwenberg AJM (1991) *A Revision of Tabernaemontana: The Old World Species*. Royal Botanic Gardens, Kew, 205 pp.
- Lim F (2016) Coney Island (Pulau Serangoon). Singapore Infopedia. National Library Board, Government of Singapore. https://eresources.nlb.gov.sg/infopedia/articles/SIP_243_2005-01-19.html (Accessed 25 March 2020).
- Liogier HA & Martorell LF (2000) *Flora of Puerto Rico and Adjacent Islands: A Systematic Synopsis*. 2nd Edition Revised. Editorial de La Universidad de Puerto Rico, San Juan, 382 pp.
- National Parks Board (2001) *Trees of Our Garden City: A Guide to Common Trees of Singapore*. 1st Edition. National Parks Board, Singapore, 202 pp.
- Ong KH (2015) *Fatoua villosa*. The Plant Observatory. <http://www.natureloveyou.sg/Fatoua%20villosa/Main.html> (Accessed 13 May 2020).
- Prain D (1897) Order XXXVIII. Leguminosae. Materials for flora of the Malayan Peninsula. *Journal of the Asiatic Society of Bengal*, Part 2, Natural History, 66: 21–275.
- Ridley HN (1922) *The Flora of the Malay Peninsula*. Volume 1. L. Reeve & Co. Ltd, London, xxxv + 918 pp.
- Wu Z, Zhou Z & Gilbert MG (2003) *Moraceae*. *Flora of China*, 5: 21–73.
- Wunderlin RP (1997) *Moraceae*. *Flora of North America North of Mexico*, 3: 388–399.