

Towards a field guide to the trees of the Nee Soon Swamp Forest (II): *Cratoxylum* (Hypericaceae)

Louise Neo*, K. Y. Chong, S. Y. Tan, C. Y. Koh, Reuben C. J. Lim, Jolyn W. Loh, W. Q. Ng, W. W. Seah, Alex T. K. Yee and Hugh T. W. Tan

Department of Biological Sciences, National University of Singapore, 14 Science Drive 4, Singapore 117543, Republic of Singapore Email: neolouise@nus.edu.sg (*corresponding author)

Abstract. The forests within and around Singapore's last substantial tract of intact freshwater swamp forest—Nee Soon Swamp Forest—are extremely diverse floristically, and so present challenges in the recognition of plant species. Here we provide a key and species descriptions, based on characters easily observed in the field and on dried specimens, to the Hypericaceae of the Nee Soon Swamp Forest. Only the genus *Cratoxylum* is native to Singapore, with four species, all trees, found in the Nee Soon Swamp Forest. A fifth species, *Cratoxylum glaucum*, seems to have been erroneously recorded as native to Singapore, but we could find no evidence that it has been collected from here. *Cratoxylum glaucum* has only been recorded from Peninsular Malaysia, Borneo, and other parts of Indonesia, according to taxonomic accounts for the region, and its natural distribution is not known to include Singapore.

Key words. Hypericaceae, *Cratoxylum*, Nee Soon Swamp Forest, trees, field identification, Malesia

INTRODUCTION

The Hypericaceae, named after the genus *Hypericum*, are herbs, shrubs, and trees with a worldwide distribution, united by their simple, entire, opposite, and exstipulate leaves with pellucid or dark dots in their laminae, and radially-symmetrical bisexual flowers with a superior ovary and five sepals which are persistent in the capsular fruit (Wong, 1995). Only two genera of this family occur in Singapore, *Hypericum* and *Cratoxylum*, but only *Cratoxylum* is native (Chong et al., 2009) and has been recorded from the Nee Soon Swamp Forest (NSSF) (Wong et al., 2013). Worldwide, there are six species of *Cratoxylum* (also spelled as *Cratoxylon*, an orthographic variant used in the older literature), distributed from India through South China to Malesia. Five species are recorded as native to Singapore by Chong et al. (2009). Four species have been recorded in the NSSF (Wong et al., 2013), and we provide a key to and brief descriptions of these species here. The species not recorded from the NSSF is *Cratoxylum glaucum*, and we assess that its presence and native status in Singapore is doubtful, as it has only been recorded from Peninsular Malaysia, Borneo, and other parts of Indonesia, and its natural distribution is not known to extend here (Corner, 1938; Kochummen, 1973; Robson, 1974; Wong, 1995). Moreover, there are no specimens of *Cratoxylum glaucum* collected from Singapore localities in the Singapore Botanic Gardens' Herbarium (SING), or the Herbarium, Lee Kong Chian Natural History Museum (SINU). Hence, it is likely that *Cratoxylum glaucum* was erroneously listed as a common native by Chong et al. (2009).

Vegetatively, *Cratoxylum* species can look superficially similar to the opposite-leaved genera of some other families. The Hypericaceae were once united with the Clusiaceae (or Guttiferae) because of the many phytochemical, morphological, and anatomical similarities between these two related families. Species of *Garcinia*, the single genus of the Clusiaceae native to Singapore (excluding *Calophyllum* and *Mesua* which are now placed in the Calophyllaceae according to APG III [2009]), have fine resin ducts instead of dots on the lamina, unlike *Cratoxylum* species. *Cratoxylum* species also differ from *Syzygium* (Myrtaceae) species, which have no interpetiolar scar on their twigs and no coloured exudate, and *Memecylon* (Melastomataceae) species, which have no dots on the lamina and no coloured exudate.

More recent accounts of the Hypericaceae include Kochummen (1973) for Peninsular Malaysia, Robson (1974) for Malesia, and Wong (1995) for Sabah and Sarawak. Our identifications and descriptions, especially of characters such as mature tree height, trunk girth, bark, flowers, and fruits, which we may not have personally encountered, are hence taken from these three accounts.

CRATOXYLUM Blume

(Greek *kratos*, strong; *xylon*, wood; referring to the timber)

Shrubs to large trees; evergreen, semi-deciduous, or deciduous, with some species bearing their flowers on bare branches, and others flowering with the new leaves or with the mature leaves; the trunks of some species bearing prickles at younger (sapling to pole-sized) stages. **Bark** exuding orange or yellow resinous sap which dries black. **Leaves** bright red when young; opposite, or rarely, sub-opposite, joined by an interpetiolar scar, which may be continuous (Fig. 1), or interrupted. **Flowers** with five sepals, and five petals that are white, pink, or red and which bear longitudinal glandular lines or dots on them; stamens occurring in three bundles; ovaries incompletely three-celled with three styles that are free. **Fruits** capsular, three-locular, and at maturity splitting along the internal partitions to expose seeds that are winged either all around or only on one side.

Ecology. Rare to frequent in primary forests but growing well in areas with high light levels, such as gaps or edges of forests, and disturbed sites. They can be found on well-drained to swampy ground.

Key references. Kochummen (1973: 248), Robson (1974: 1), Wong (1995: 220)

FIELD KEY TO THE CRATOXYLUM SPECIES OF THE NEE SOON SWAMP FOREST

1. A single continuous intramarginal vein present at the leaf blade margin; lateral veins numerous, close together, and faint to obscure on both leaf surfaces..... *Cratoxylum arborescens*
 - No continuous intramarginal vein at the leaf blade margin, although the main lateral veins may meet in loops; lateral veins few, well-spaced, and distinct on both leaf surfaces..... 2
2. Main lateral veins seldom forming loops near the leaf blade margin; tertiary reticulations faint to obscure. Bark peeling off in patches. *Cratoxylum cochinchinense*
 - Main lateral veins consistently forming loops near the leaf blade margin; tertiary reticulations visible. Bark fissured but not peeling off. 3
3. Leaf blade mostly longer than 10 cm, at least three times as long as it is wide; in dry leaves, lateral veins below either a distinctly darker or lighter colour than the leaf blade and slightly raised. Petiole length varying with leaf size. *Cratoxylum formosum*
 - Leaf blade mostly not exceeding 10 cm long, about two times as long as it is wide; in dry leaves, lateral veins below slightly darker than the leaf blade and visibly raised. Petiole about 5 mm long regardless of leaf size. *Cratoxylum maingayi*

1. *Cratoxylum arborescens* (Vahl) Blume
(Latin *arbor*, tree)

Evergreen tree or shrub to 45 m tall; trunk with girth to 200 cm, with or without buttresses to 1 m high; often with prickles at the sapling stage. **Bark** grey to dark brown or reddish-brown, smooth to fissured-cracking and papery scaly, inner bark pink to pale brown, finely laminated, sapwood pale yellow. **Leaves** with leaf blade elliptic to obovate, drying 5.5–19.5 × 2–5.5 cm but usually about 9 × 4 cm, coriaceous, sometimes slightly glaucous below, both surfaces densely covered with tiny black dots when dry that are visible with a ×10 hand lens, midrib flat to sunken above, *lateral veins numerous, close together, very faint on both surfaces, running straight to the margin and meeting with a single, continuous intramarginal vein about 1–2 mm from the margin*, apex acuminate or caudate, base cuneate to attenuate; petiole drying 4–12 mm long; interpetiolar scar continuous. **Flowers** many in a terminal panicle; petals usually pink to deep red but can be orange or white, with punctate glands and a basal scale up to 1 mm long. **Fruit** capsular, cylindrical, with persistent sepals to half or more than half of the fruit length. **Seeds** 10–18 per locule, each with a wing all around. — Figs. 2, 3.



Fig. 1. A continuous interpetiolar scar (arrowed) between a pair of opposite leaves that is typical of some *Cratoxylum* species. Scale bar = 1 cm. (Photograph by: Louise Neo).

Singapore localities. Nee Soon Swamp Forest (A. T. Gwee, P. T. Chew, I. Hassan, & H. K. Lua SING 2009-203) and the surrounding Upper Peirce Reservoir (E. Tang & H. Sidek 884) and Upper Seletar Reservoir (P. Leong, D. Liew, J. Skornickova & H. D. Tran SING 2011-047). Also previously collected from Bukit Timah (D. Liew SF36480), Changi (H. N. Ridley 3611a), the Singapore Botanic Gardens Rainforest (R. Hassan SF36280), and Jurong Road (E. J. H. Corner s.n. SING barcode no. 0018144).

Habitats. Dryland primary and secondary forest, and also peat swamp and freshwater swamp forest. In the NSSF, we collected this species from both dry and wet forest.

Conservation. Nationally Vulnerable (Tan et al., 2008)

Suggested common name. geronggang (the trade name for the timber)

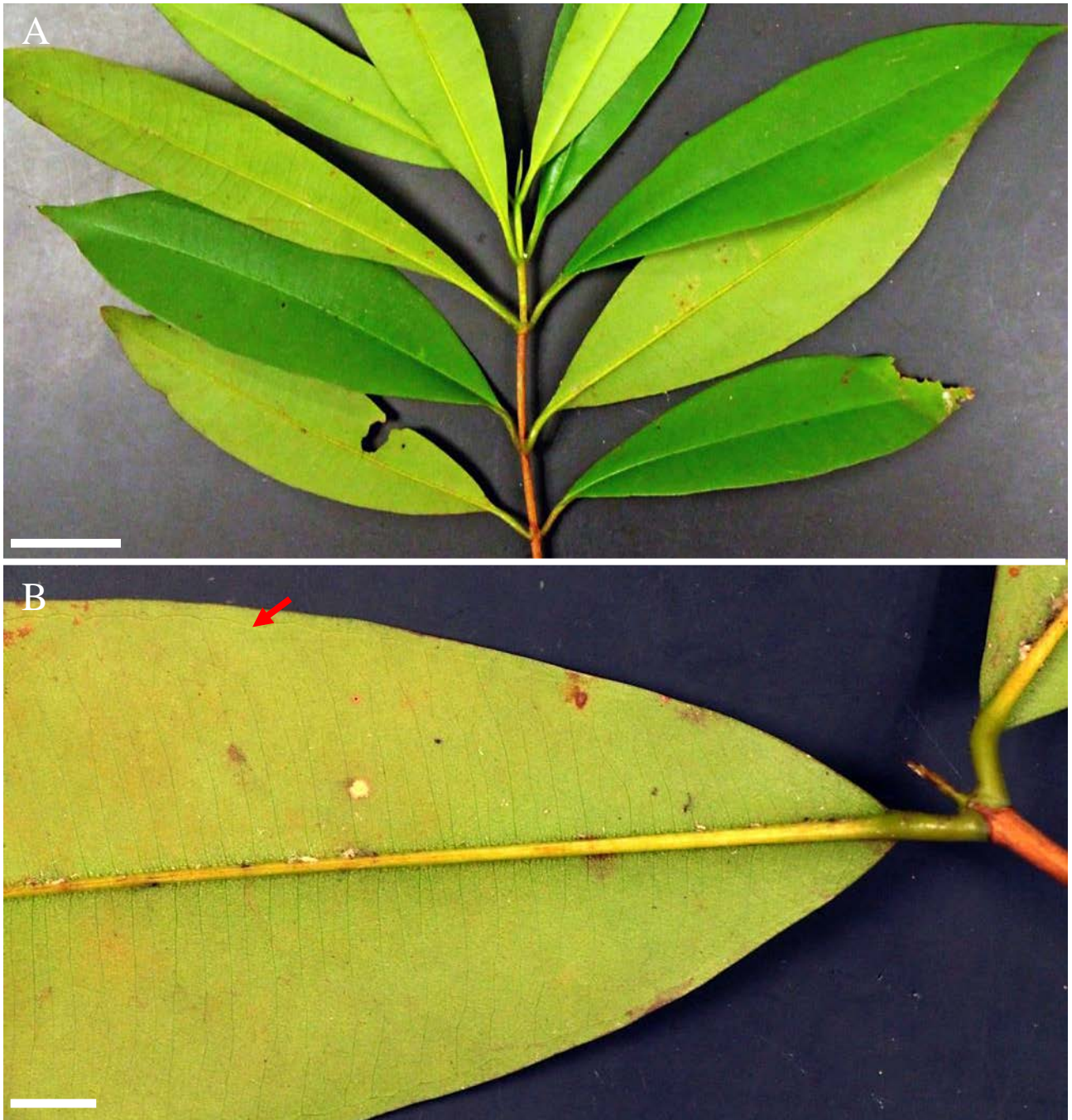


Fig. 2. *Cratoxylum arborescens*. A, Leafy twig; B, Lateral veins numerous, close together, and faint on the leaf underside, meeting at the leaf blade margin in a single continuous intramarginal vein running parallel to the margin (arrowed). Scale bar = 2 cm [A]; 1 cm [B]. (Photograph by: Louise Neo).

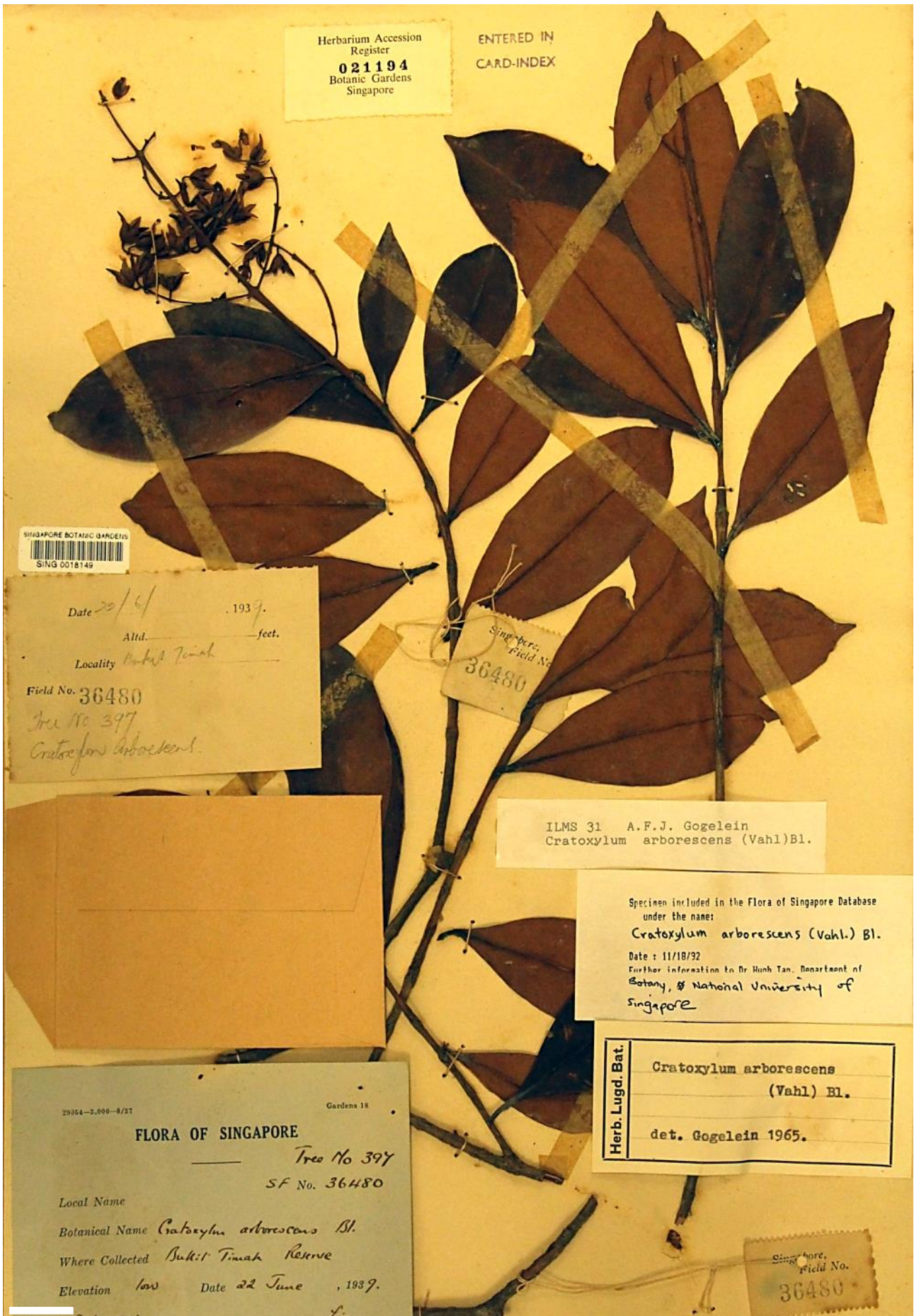


Fig. 3. *Cratoxylum arborescens*. Herbarium sheet specimen of fruiting and leafy twigs, D. Liew SFN 36480, Bukit Timah Reserve, SING barcode 0018149. Scale bar = 2 cm. (Photograph by: Louise Neo).

2. *Cratoxylum cochinchinense* (Lour.) Blume

(from Cochinchina, the southern region of Vietnam during its French colonial period)

Deciduous tree or shrub to 30 m tall; trunk with girth to 180 cm, sometimes prickly and occasionally buttressed. **Bark** pale brown to reddish-brown, smooth to flaky or papery and may *peel off in angular pieces or in long strips*, inner bark greenish yellow to pink, thin, sapwood white to yellowish. **Leaves** with leaf blade *lanceolate* or elliptic, drying 3–12 × 1–3.5 cm but usually about 8 × 2.5 cm, *chartaceous to thinly coriaceous*, usually glaucous below, both surfaces of the lamina densely covered with tiny black dots when dry which can be seen using a hand lens, midrib sunken above, main lateral veins (i.e., those that extend all the way to the margin) 6–15 well-spaced pairs, *faint to visible above and below, only sometimes closing up in loops 1–2 mm away from the margin and it is usually difficult to definitively determine the point of looping*, and not forming a single, continuous intramarginal vein, tertiary reticulations faint to obscure above and below, and forming very small, tight cells, apex attenuate, acuminate, or caudate, base cuneate to attenuate; petiole drying 2–4 mm long; interpetiolar scar continuous or interrupted. **Flowers** 1–5 in axillary or terminal cymes; petals usually deep red but can also be pink or orange, with linear glands and without a basal scale. **Fruit** capsular, ellipsoid-cylindrical, with persistent sepals of more than half of the fruit length. **Seeds** 5–8 per locule, each with a wing on only one side. — Figs. 4, 5.

Singapore localities. Nee Soon Swamp Forest (I. M. Turner & G. C. H. Tan 172). Also previously collected from Bukit Timah (M. S. Khoo KMS 2; Mohd Noor MN 1101), Bukit Mandai (H. N. Ridley 358a), and the Singapore Botanic Gardens (E. J. H. Corner 33138).

Habitats. Dryland primary or secondary forest and open woodlands, usually on well-drained soil. In the NSSF, we collected this species from dry forest.

Conservation. Nationally Endangered (Tan et al., 2008)

Suggested common name. red mempat.



Fig. 4. *Cratoxylum cochinchinense*. A, Flaky bark that peels off in long pieces; B, Lateral veins well-spaced and visible below, not forming a single, continuous intramarginal vein. Scale bar = 1 cm [A]; 0.5 cm [B]. (Photograph by: Louise Neo).

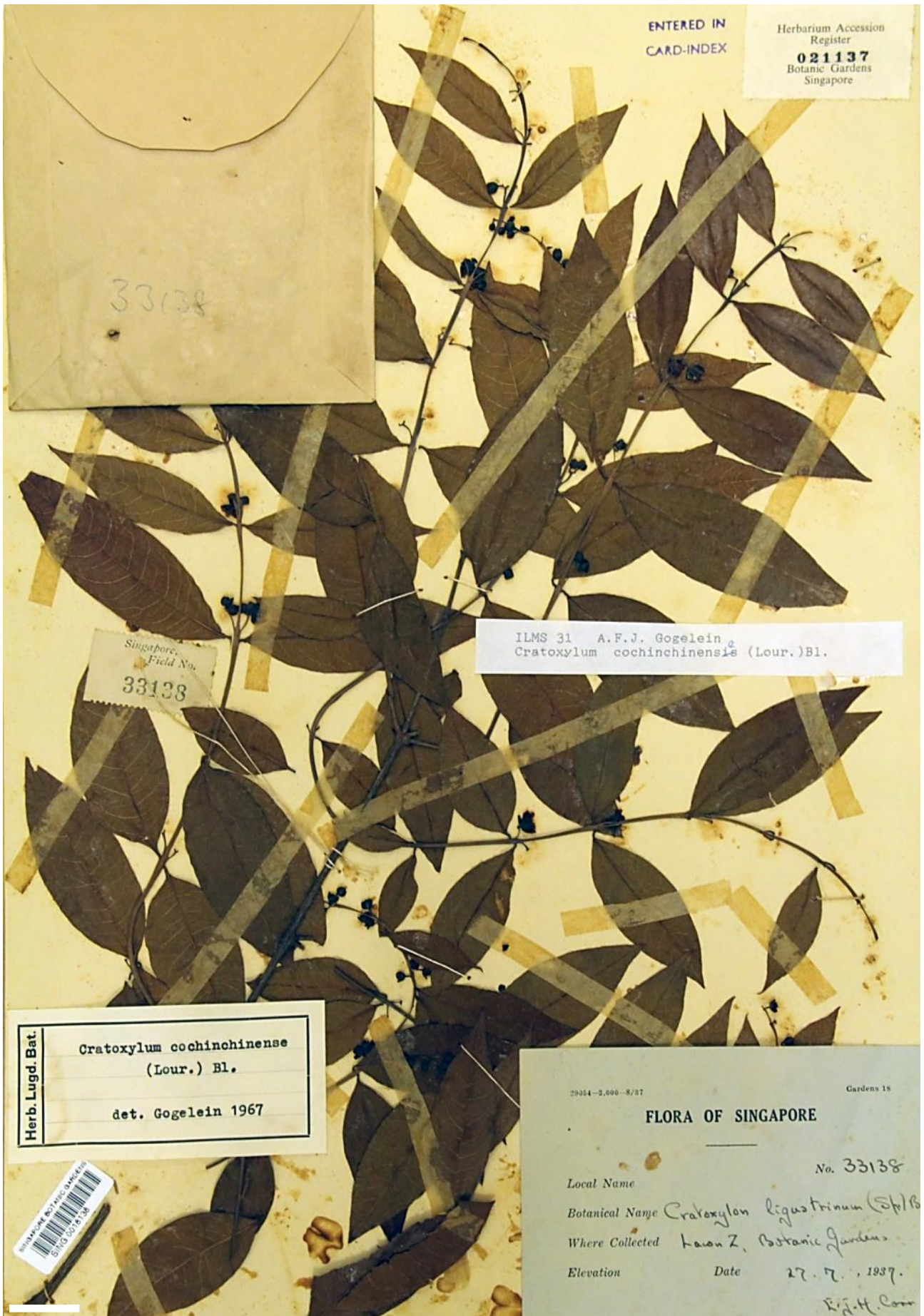


Fig. 5. *Cratoxylum cochinchinense*. Herbarium sheet specimen of flowering, leafy twigs, E. J. H. Corner 33138, Botanic Gardens, SING barcode 0018138. Scale bar = 2 cm. (Photograph by: Louise Neo).

3. *Cratoxylum formosum* (Jack) Dyer
(Latin *formosus*, beautiful, referring to the attractive flowers)

Deciduous tree or shrub, to 35 m tall; trunk with girth to 180 cm, sometimes prickly at the base. **Bark** grey to reddish-brown, coarsely-fissured, scaly, inner bark yellowish, sapwood pale yellowish. **Leaves** with leaf blade elliptic or obovate, drying 5.5–14 × 2–7.5 cm *but usually about 11 × 4 cm*, sub-coriaceous to coriaceous, sometimes glaucous below, both surfaces of the lamina covered with tiny black dots which when dry can be seen using a hand lens, midrib sunken above, main lateral veins (i.e., those that extend all the way to the margin) 8–11 well-spaced pairs, visible above and below, *drying either a lighter or darker colour than the leaf blade below and slightly raised to the naked eye and to the touch, always closing up in loops 2–5 mm away from the margin and each point of loop closure is distinct, and with additional loops present beyond these*, not forming a single, continuous intramarginal vein, tertiary reticulations visible above and below, apex rounded, acute, or attenuate, base rounded, cuneate, or attenuate; petiole drying 4–13 mm long; interpetiolar scar interrupted. **Flowers** may be single, opposite, and axillary, or in 1–6-flowered axillary cymes; petals usually light pink or white, but can also be red or, very rarely, purplish, with punctate glands and a basal scale 2–4 mm long. **Fruit** capsular, ellipsoid, with persistent sepals to only a third of the fruit length. **Seeds** 7–17 per locule, each with a wing only on one side. — Figs. 6, 7.

Singapore localities. Nee Soon Swamp Forest (Samsuri Ahmad, S. K. Ganesan, P. Leong & A. T. Gwee NES 255). Also collected from Bukit Timah (Mohd Noor MN 1187).

Habitats. Primary or secondary forest, on hill slopes, river banks, and in swamps. In the NSSF, this species was collected from a swampy area.

Conservation. Nationally Endangered (Tan et al., 2008)

Suggested common name. pink mempata

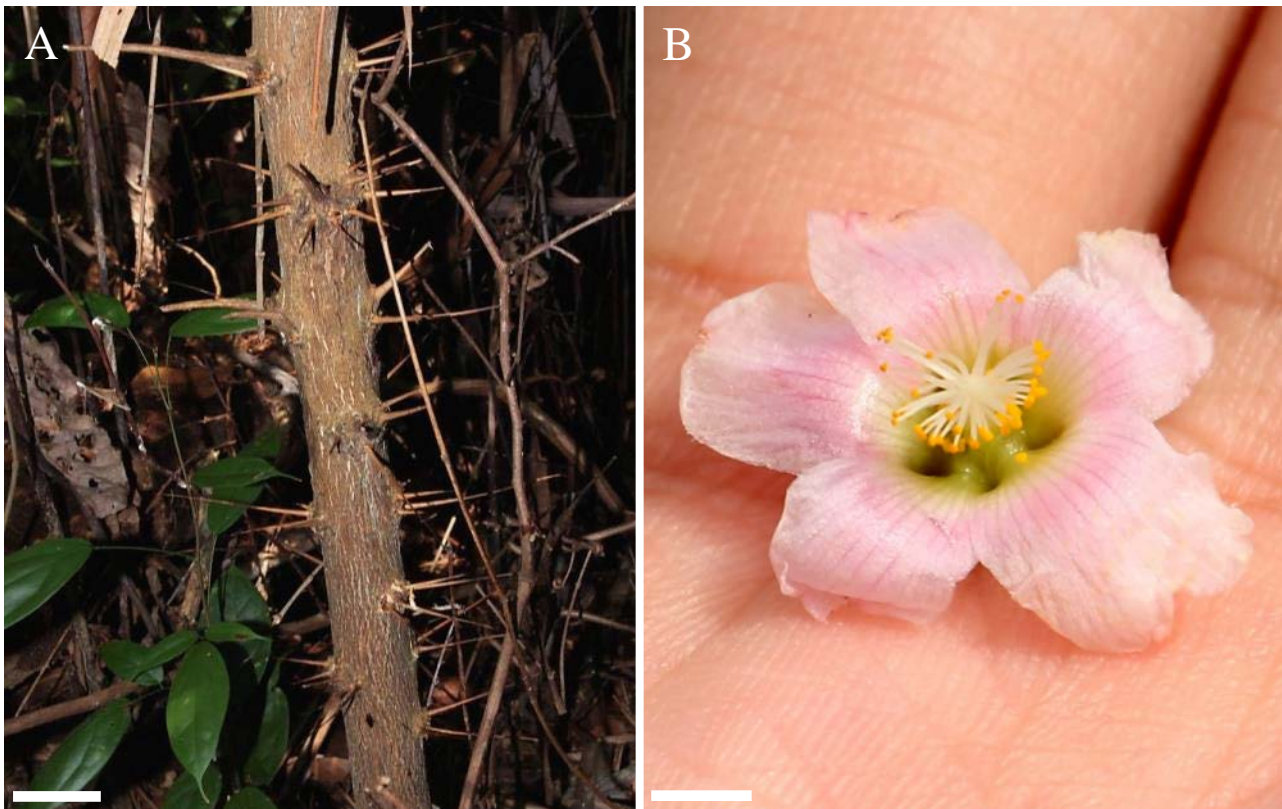


Fig. 6. *Cratoxylum formosum*. A, Trunk of a young tree with prickles; B, Flower with light pink petals. Scale bar = 2 cm [A]; 0.2 cm [B]. (Photograph by: Louise Neo).

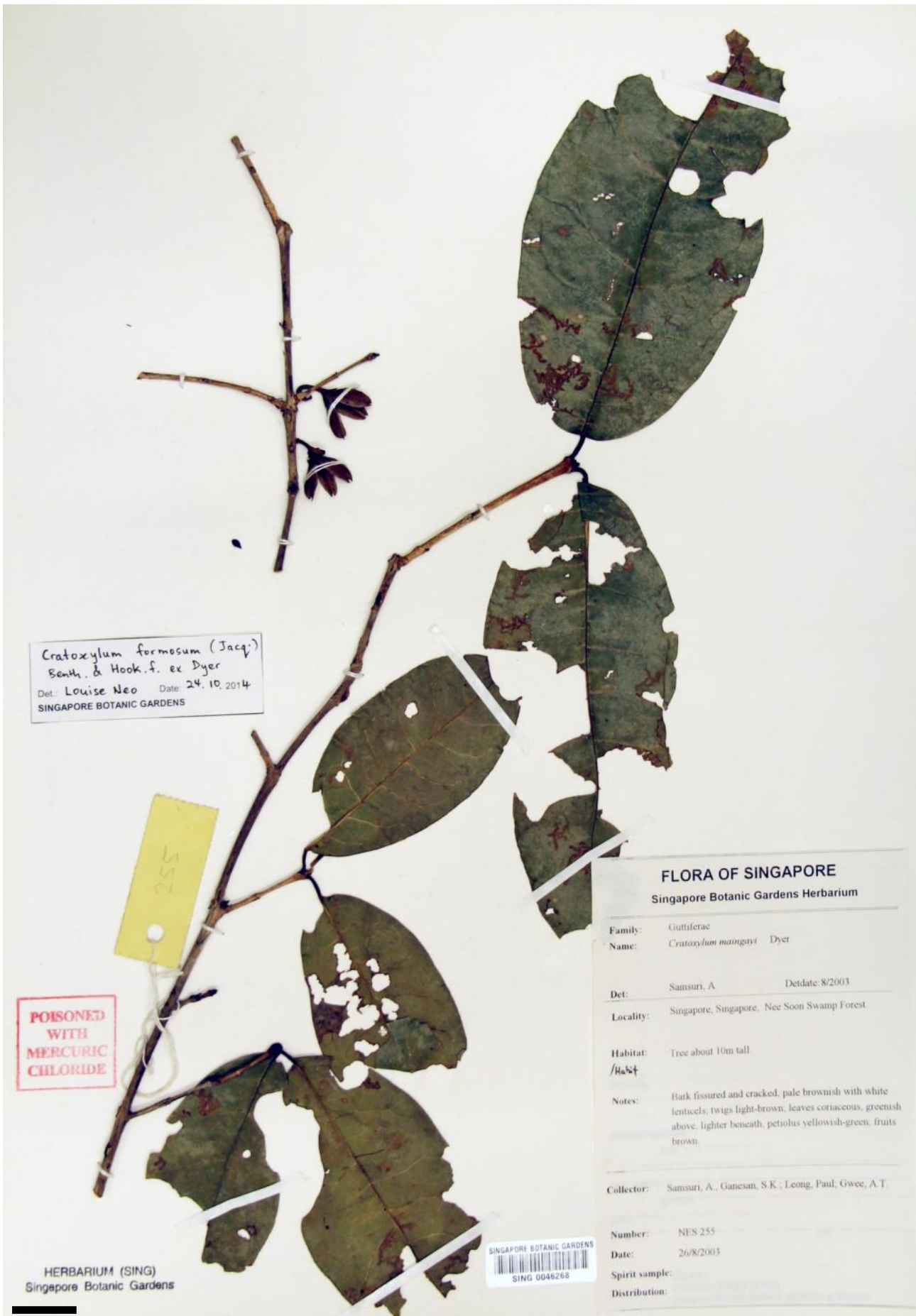


Fig. 7. *Cratoxylum formosum*. Herbarium sheet specimen of fruiting and leafy twigs from Nee Soon, Samsuri Ahmad, S. K. Ganesan, P. Leong & A. T. Gwee NES 255, Nee Soon Swamp Forest, SING barcode 0046268. Scale bar = 2 cm. (Photograph by: Louise Neo).

4. *Cratoxylum maingayi* Dyer

(after Alexander Carroll Maingay (1836–1869), a botanist of the East India Company)

Deciduous or partly deciduous tree or shrub, to 20 (rarely 35) m tall; trunk girth to 180 cm. **Bark** dark greyish-brown, smooth to narrowly-fissured with small scales. **Leaves** with leaf blade ovate-lanceolate, elliptic, or obovate, drying 2–9(–11) × 1.5–4.5(–6) cm *but usually about 6.5 × 3 cm*, sub-coriaceous to coriaceous, not glaucous beneath, both surfaces of the lamina covered with tiny black dots which when dry can be seen using a hand lens, midrib flat to sunken above, main lateral veins (i.e., those that extend all the way to the margin) 5–7(–14) well-spaced pairs, visible above and below, *drying the same colour as the leaf blade below and slightly raised to the naked eye and to the touch, always closing up in loops at 1–5 mm away from the margin and each point of loop closure is distinct, and with additional loops present beyond these*, tertiary reticulations visible above and below, apex rounded, obtuse, attenuate, or acuminate, base cuneate; petiole drying (4–)5–9 mm long *but usually about 5 mm long regardless of leaf size*; interpetiolar scar interrupted. **Flowers** may be single, opposite, and axillary, or in 1–4-flowered axillary cymes; petals pink or white, with punctate glands and a basal scale 2–3 mm long. **Fruit** capsular, fusiform, with persistent sepals of nearly half of the fruit length. **Seeds** 5–6 per locule, each with a wing only on one side. — Figs. 8, 9.

Singapore localities. Nee Soon Swamp Forest (A. T. Gwee SING2010-383). Also previously collected from Bukit Timah (J. Sinclair SF40037; Liew SF36463), Mandai (A. T. Gwee SING2010-203), the Western Catchment Area (A. T. Gwee, C. Tan, A. Chia, T. P. Ng, I. Ali & S. L. Tay WC107), and the Singapore Botanic Gardens (Ahmat s. n. SING barcode no. 0018164).

Habitats. Lowland forests and limestone hills. In the NSSF, we collected this species from dry forest.

Conservation. Nationally Critically Endangered (Tan et al., 2008)

Suggested common name. Maingay's mempat

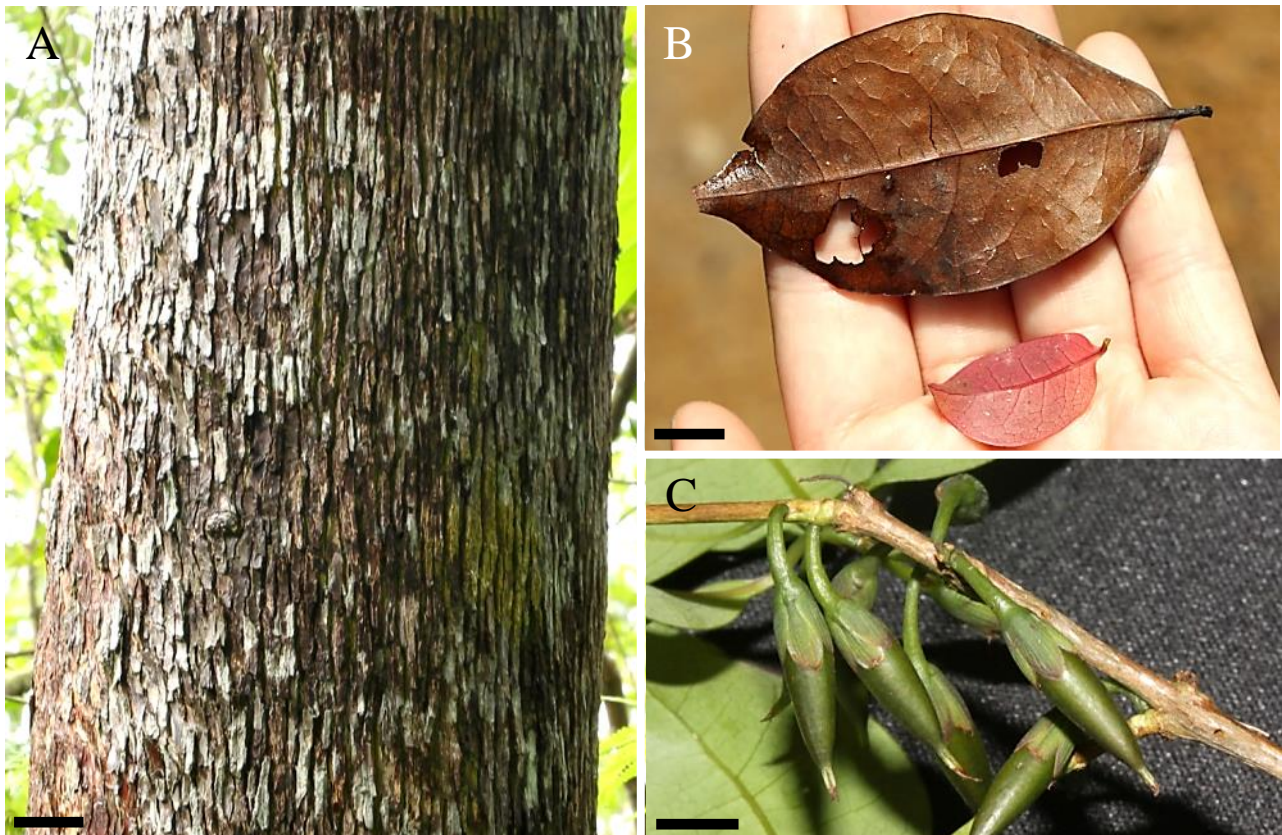


Fig. 8. *Cratoxylum maingayi*. A, Narrowly-fissured bark of a large tree; B, Fallen young leaf compared beside a dry mature leaf with the main lateral veins well-spaced and visibly raised on the underside; C, Fusiform capsules with persistent sepals to nearly half of the fruit length. Scale bar = 5 cm [A]; 1 cm [B]; 0.5 cm [C]. (Photograph by: Louise Neo).



Fig. 9. *Cratoxylum maingayi*. Herbarium sheet specimen of leafy twigs from Nee Soon, A. T. Gwee SING 2010-383, Nee Soon Swamp Forest, SING barcode 0145321. Scale bar = 2 cm. (Photograph by: Louise Neo).

ACKNOWLEDGEMENTS

This work was conducted as part of the Nee Soon Swamp Forest Biodiversity and Hydrology Baseline Studies—Phase 2 Project funded by the National Parks Board, Singapore, under the permit number NP/RP13-009 and National University of Singapore grant account number R-347-000-198-490. We would like to thank Serena Lee and Siti Nur Bazilah Mohamed Ibrahim for facilitating our access to the specimens deposited in the Singapore Botanic Gardens' Herbarium. We are very grateful to Wong Khoon Meng for advice to improve this manuscript.

LITERATURE CITED

- APG III (2009) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. *Botanical Journal of the Linnean Society*, 161: 105–121.
- 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. http://lkcnhm.nus.edu.sg/nus/pdf/PUBLICATION/LKCNH%20Museum%20Books/LKCNHM%20Books/flora_of_singapore_tc.pdf. (Accessed 14 December 2015).
- Corner EJH (1938) Notes on the systematics and distribution of Malayan phanerogams, I. *Gardens' Bulletin, Singapore*, 10: 21–36.
- Kochummen KM (1973) Hypericaceae. *Tree Flora of Malaya*, 2: 248–252.
- Robson NKB (1974) Hypericaceae. *Flora Malesiana, Series I*, 8: 1–29.
- Tan HTW, Tan K-x, Ali bin Ibrahim, Chew PT, Chua KS, Duistermaat H, Ganesan SK, Goh MWK, Gwee AT, Kiew R, Lee SML, Leong P, Lim J, Lok AFSL, Loo AHB, Lum SKY, Morgany T, Saifuddin bin Suran, Sim S, Haji Samsuri bin Haji Ahmad, Wee YC, Yap KF, Yeo CK & Yong JWH (2008) Checklists of threatened species—Seed plants. In: Davison GWH, Ng PKL & Ho HC (eds.) *The Singapore Red Data Book: Threatened Plants & Animals of Singapore*. 2nd Edition. Nature Society (Singapore), Singapore. Pp. 213–244.
- Wong HF, Tan SY, Koh CY, Siow MHJ, Li T, Heyzer A, Ang AHF, Mirza Rifqi bin Ismail, Srivathsan A & Tan HTW (2013) Checklist of Plant Species of Nee Soon Swamp Forest, Singapore: Bryophytes to Angiosperms. National Parks Board and Raffles Museum of Biodiversity Research, National University of Singapore, Singapore. 521 pp. Uploaded 13 May 2013. http://lkcnhm.nus.edu.sg/nus/pdf/PUBLICATION/LKCNH%20Museum%20Books/LKCNHM%20Books/NSSF_FloraChecklist.pdf. (Accessed 14 December 2015).
- Wong KM (1995) Hypericaceae. *Tree Flora of Sabah and Sarawak*, 1: 219–226.