

Towards a field guide to the trees of the Nee Soon Swamp Forest (V): Burseraceae

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Abstract. This paper is the fifth instalment of a continuing series on the tree species of the floristically diverse Nee Soon Swamp Forest, Singapore's last substantial tract of intact freshwater swamp forest. Here, we provide a field key and descriptions, based on characters easily observed in the field and from dried specimens, to the 13 species of the four genera of Burseraceae found there. They are: *Canarium* (three species), *Dacryodes* (four species), *Santiria* (five species), and *Triomma* (one species). Amongst these, *Dacryodes incurvata* has been reported as a new addition to the flora of Singapore.

Key words. Burseraceae, Nee Soon Swamp Forest, trees, field identification

INTRODUCTION

The family Burseraceae is named after the genus *Bursera*, Greek for purse, describing the fruits of species in that genus. It is also commonly referred to by the Malay name kedondong, which is the widely used trade name for the timber of this family (LaFrankie, 2010). However, the Malay name kedondong is also a commonly applied name for the edible fruits of *Spondias dulcis* Parkinson (Anacardiaceae), especially in Peninsular Malaysia and Indonesia. Therefore, care must be taken when using the common names of the different species in order to avoid confusion. The Burseraceae is represented by about 16–20 genera and 550–755 species, mainly distributed in the tropics and subtropics (Leenhouts, 1956; Kochummen, 1995; LaFrankie, 2010; Utteridge & Bramley, 2014). The actual number of genera and species varies with the time of publication by different authors. In Singapore, the Burseraceae is represented by four genera: *Canarium*, *Dacryodes*, *Santiria*, and *Triomma*, and all can be found in the Nee Soon Swamp Forest (NSSF).

Members of the family are typically medium- to large-sized trees with buttresses and are rarely shrubs (Leenhouts, 1956; Kochummen, 1972, 1995; LaFrankie, 2010). An important distinguishing characteristic for members of the family is that all living parts of the plant exude a characteristically strong aromatic, resinous smell, often described as a turpentine- or mango-like scent, when crushed (Kochummen, 1995). The bark of Burseraceae is pale coloured, often grey or brown and smooth or scaly textured, often with many lenticels. The surface of the bark is also sometimes covered with white, brown or rarely, black resin gum. The leaves are alternate or spirally arranged and imparipinnate (rarely otherwise, as in *Santiria griffithii*), with opposite leaflets and a terminal leaflet. The leaflet stalks of the leaflets are often swollen at both ends and the margins of the leaflets are sometimes serrated (for many *Canarium* spp.), but more often they are entire. In addition, stipule-like structures (variously called stipules or pseudo-stipules by different authors) inserted at or near the base of the leaf stalk are usually present for the *Canarium* spp. (Leenhouts, 1956; Kochummen, 1972, 1995; LaFrankie, 2010; Utteridge & Bramley, 2014). The inflorescences are axillary, terminal or sometimes pseudo-terminal panicles. The flowers are unisexual, with male and female flowers borne on different trees, and are 3–5-merous (Leenhouts, 1956; Kochummen, 1972, 1995). The fruit is usually a drupe with a fleshy or leathery resinous outer layer and a woody stone, except *Triomma*, which has a woody winged capsule. The seeds have fleshy cotyledons that are lobed or entire and contain oil. The saplings often have narrower leaflet blades with longer apices and leaflet stalks. Although members of the Burseraceae may appear superficially similar to members of other pinnate-leafed families, such as the Meliaceae and Simaroubaceae, especially in the absence of flower and fruits, the characteristic resinous smell as well as the long, swollen leaflet stalks mentioned above are usually sufficient distinctions (Leenhouts, 1956; Kochummen, 1972).

The more recent accounts of the Burseraceae include Leenhouts (1956) for Malesia, Kochummen (1972) for Peninsular Malaysia, and Kochummen (1995) for Sabah and Sarawak. Revisions of the individual genera of the Burseraceae include Kalkman (1954) for *Dacryodes*, *Santiria*, and *Triomma* and Leenhouts (1959) for *Canarium*. Our identifications and

descriptions, especially for characters such as mature tree height, bark, inflorescences, fruits and seeds, which we have not observed for all species, are therefore based on those of these accounts.

Chong et al. (2009) listed 16 species from four genera that are native to Singapore. Wong et al. (2013) listed 12 species from four genera that are found in Nee Soon Swamp Forest. Amongst the species listed in Wong et al. (2013), we have determined two species, *Santiria rugosa* and *Dacryodes puberula*, to have been wrongly identified, and they have been re-determined to be *Santiria rubiginosa* and *Santiria apiculata*, respectively, after examination of the specimens. We also could not confirm the identity of a tree, which we encountered that resembled *Dacryodes puberula* as the tree had died. Therefore, those two species are excluded from this field guide. On the other hand, three species not listed in Wong et al. (2013), *Dacryodes incurvata*, *Dacryodes rugosa*, and *Santiria tomentosa*, were collected and identified by us and assessed to be newly recorded for the Nee Soon Swamp Forest. These are included here. Of the three species, *Dacryodes incurvata* is of particular interest as it was an overlooked record for Singapore. The species was last collected in 1940 along Mandai Road and was listed in the checklists of Corner (1978), Turner et al. (1996), and Chew et al. (1997), but was not listed in Chong et al. (2009). It has since been reported as an addition to the flora by Chong et al. (2018). Taking into account these changes, here we provide a key to genera, a field key to species and descriptions, based on characters easily observed in the field and from dried specimens, to the 13 species from four genera for which we have deduced their identities.

KEY TO THE GENERA OF BURSERACEAE OF THE NEE SOON SWAMP FOREST

1. Leaflet blade margin serrated. Stipule-like structures usually present, sometimes absent. *Canarium* (in part)
- Leaflet blade margin entire. Stipule-like structures present or absent. 2
2. Stipule-like structures present. *Canarium patentinervium*
- Stipule-like structures absent. 3
3. Flowers 5-merous. Fruit a woody winged capsule. *Triomma malaccensis*
- Flowers 3-merous. Fruit a fleshy drupe. 4
4. Receptacle cupular. *Canarium*
- Receptacle flat. 5
5. Stigma situated more-or-less at the apex of the fruit. *Dacryodes*
- Stigma situated distinctly off-centre from the apex of the fruit. *Santiria*

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

1. Leaflet blade margin faintly to distinctly serrated, especially towards the apex; secondary veins usually arching near the margin and sometimes looping, especially towards apex. Stipule-like structures usually present and inserted near the base of the leaf stalk. 2
- Leaflet blade margin entire; secondary veins arching, looping or forking near or some distance from the margin. Stipule-like structures present or absent. 3
2. Twigs, leaf stalks and rachises usually glabrous to densely tomentose, hairs less than 5 mm long. Stipule-like structures caducous and kidney-shaped. *Canarium* aff. *littorale*
- Twigs, leaf stalks and rachises usually distinctly pilose, hairs to 5 mm long. Stipule-like structures usually persistent and awl-shaped. *Canarium pilosum* ssp. *pilosum*
3. Stipule-like structures when present, caducous and oval- to kidney-shaped. If absent in material, leaflet blade ovate to oblong-lanceolate; secondary veins widely spaced and distinctly looping at some distance from the margin; tertiary veins inconspicuous; midrib sunken, especially towards the base, to flat above. *Canarium patentinervium*
- Stipule-like structures absent and leaflet blade, secondary veins, tertiary veins and midrib otherwise. 4
4. Leaflet blade densely tomentose on the lower surface. *Santiria tomentosa*
- Leaflet blade generally glabrous on the lower surface, sometimes with pubescent secondary veins and midrib. 5
5. Leaflet blade intermediate veins distinct and extending almost parallel to the secondary veins, halfway or reaching to the margin; tertiary veins faintly reticulate. 6
- Leaflet blade intermediate veins absent or indistinct; tertiary veins distinctly transverse or reticulate. 7

6. Leaflet blade base rounded or obtuse and almost always symmetrical; secondary veins extending nearly right-angled to the midrib, distinctly arching near the margin; midrib flattened to slightly sunken above (better observed under 20× magnification).*Santiria griffithii*
 – Leaflet blade base cuneate and almost always asymmetrical; secondary veins extending straight at an acute angle to the midrib, forking or less distinctly arching near the margin; midrib ridged, raised or flattened above (better observed under 20× magnification).*Santiria rubiginosa*
7. Leaflet blade secondary veins nearly right-angled to midrib. 8
 – Leaflet blade secondary veins at 50° to 70° to midrib. 9
8. Terminal buds usually covered in resin. Leaf stalks usually channelled above. Leaflet stalk blackish at both ends when dry.*Santiria laevigata*
 – Terminal buds not covered in resin. Leaf stalks usually flat above. Leaflet stalk not blackish at both ends when dried. *Dacryodes incurvata*
9. Twigs, leaf stalks and leaflet stalks whitish. Leaflet blade midrib distinctly striate below when dry; secondary veins and midrib yellowish below when dried.*Santiria apiculata* var. *apiculata*
 – Twigs, leaf stalks and leaflet stalks brownish or dark. Leaflet blade midrib sometimes striate below when dry; secondary veins and midrib brownish below when dry. 10
10. Leaflet blade base strongly asymmetrical to distinctly oblique; secondary veins pinkish brown when dry; leaflet stalks only slightly swollen at both ends.*Triomma malaccensis*
 – Leaflet blade base rounded to oblique; secondary veins never pinkish brown when dry; leaflet stalks markedly swollen at both ends. 11
11. Leaflet blade secondary veins and midrib glabrous below; apex gradually acuminate, often with a long, broadened and blunt tip.*Dacryodes rostrata* aff. f. *rostrata*
 – Leaflet blade secondary veins and midrib puberulous to pubescent below; apex abruptly acuminate, often with a long tapered tip. 12
12. Leaf stalks distinctly flattened above; leaf stalks and rachises distinctly pubescent. Leaflet blade secondary veins 6–13 pairs, strongly curved; leaflet blade smooth. Twigs brown. *Dacryodes costata*
 – Leaf stalks distinctly rounded or swollen above; leaf stalks and rachises minutely lenticellate and/ or glabrous to puberulous. Leaflet blade secondary veins 7–10 pairs, slightly curved; leaflet blade often bullate. Twigs fawn with thin papery outer bark.*Dacryodes rugosa* var. *rugosa*

CANARIUM Stickman

(Latinised form of *kenari*, the Moluccan name for the *kenari*-nut tree)

Medium- to large-sized, buttressed tree, rarely a shrub. **Leaves** spiral; stipule-like structures present, of various shapes, often more-or-less near the base of the leaf stalk. **Inflorescence** an axillary or terminal panicle, often reduced, especially for female ones, which are smaller. **Flowers** unisexual, 3-merous, receptacle cupular, especially for female ones. **Fruit** a drupe, oblong or ellipsoid, seated on the persistent, enlarged calyx.

1. *Canarium* aff. *littorale* Bl.

(Latin *littoralis*, of the seashore, referring to its habitat)

Key references. Leenhouts (1956: 256–258); Leenhouts (1959: 337–341); Kochummen (1972: 130–131); Kochummen (1995: 57–58).

Medium- to large-sized tree, approximately 10–30 m tall, rarely to 44 m tall; trunk diameter 0.2–0.7 m, rarely to 1 m; sometimes with buttresses. **Bark** grey-green to yellowish brown, smooth to scaly or dimpled, with many small lenticels, outer bark thin, inner bark pink to red-brown, soft, laminated, sometimes oozing droplets of cloudy sticky resinous exudate, sapwood pale white or yellow, heartwood pink. **Twigs** glabrous or rusty red tomentose, especially towards the tips. **Leaves:** leaf stalks glabrous to densely tomentose, *stipule-like structures caducous or sub-persistent, on twigs or near the base of leaf stalk, kidney-shaped, nearly always tomentose*; leaflets 5–11, blade drying reddish brown, elliptic to oblong-elliptic or oblong-ovate to ovate, 5.0–16.0 × 2.0–7.5 cm, coriaceous to sub-coriaceous, upper surface glabrous, sometimes with a densely reddish-brown tomentose midrib and secondary veins, lower surface glabrous—sometimes glaucous—or densely reddish-brown tomentose, secondary veins 9–16, strongly arching near the margin, tertiary veins reticulate, apex acute to acuminate, *margin faintly to distinctly serrated*, base rounded to sub-cordate, sometimes cuneate; leaflet stalks slightly swollen at the base, glabrescent to tomentose. **Inflorescence** terminal, sometimes with some in the

upper leaf axils, sometimes glabrous, often densely reddish-brown tomentose. **Fruit** ellipsoid to obovoid, rounded, triangular in cross-section, 4.5–7 × 1.5–3.0 cm.—Fig. 1.

Singapore localities. Nee Soon Swamp Forest (A. Samsuri, S. Lee, A. T. Gwee, Md Noor, P. Leong, & S. K. Ganesan NES 5; A. Samsuri, S. K. Ganesan, S. Lee, P. Leong, & A. T. Gwee NES 240), Chan Chu Kang (H. N. Ridley 44 & 351) and “Selitar” (Bakar s.n. SING barcode number 0004099; Mat 6358). Previously collected from the Bukit Timah Nature Reserve (J. Sinclair SFN 39662; K. L. Chang s.n. SING barcode number 0004103), Changi (H. N. Ridley 1812 & 1867), and MacRitchie Reservoir (E. J. H. Corner SFN 33553). Recently collected from Chestnut Avenue (A. T. Gwee, P. T. Chew, & Ali Ibrahim et al. SING 2008-164).

Habitat. Found in both dry and swampy areas of the NSSF. According to Leenhouts (1959: 341), this species is found in rainforests on dry or swampy soils, mostly at low altitudes, rarely up to 2,000 m.

Conservation. Not threatened.

Remarks. Leenhouts (1959: 338) described this species as being highly variable. He also recognised five forms, namely *f. littorale*, *f. purpurascens* (Benn.) Leenh., *f. pruinatum* (Engl.) Leenh., *f. tomentosum* (Bl.) Leenh., and *f. rufum* (Benn.) Leenh. Among these forms, recent specimens collected from the NSSF are comparable to *f. rufum* because of their leaflet blades, which are densely tomentose below. Some historical specimens that have been collected from Chan Chu Kang are also comparable to *f. purpurascens* as their leaflets blades are glaucous below. A key for distinguishing the two forms is provided below:

1. Leaflet blade glabrescent and distinctly glaucous below. *Canarium* aff. *littorale* f. *purpurascens*
- Leaflet blade densely tomentose and not glaucous below. *Canarium* aff. *littorale* f. *rufum*

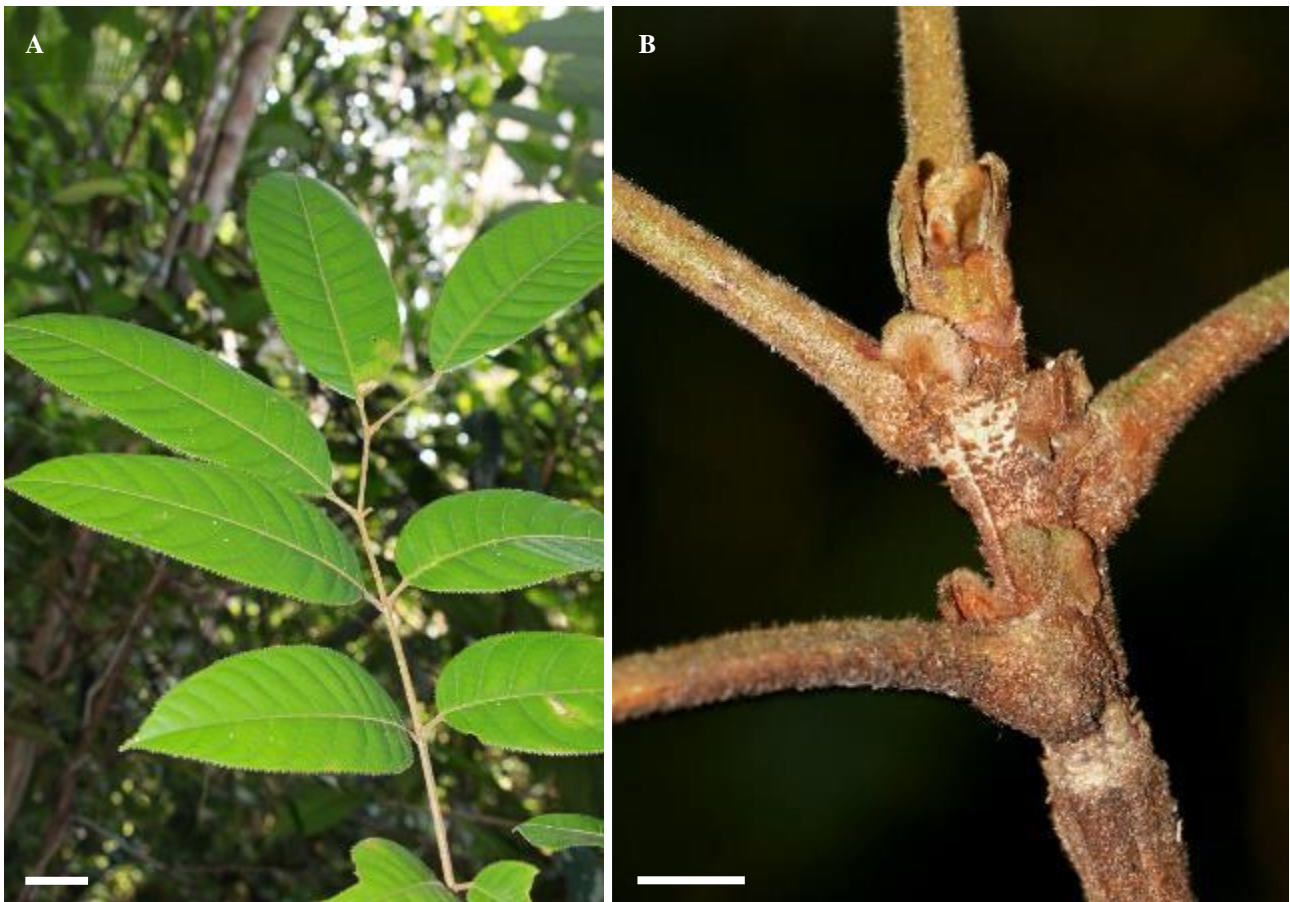


Fig. 1. *Canarium littorale* aff. *f. rufum*. A, Leaflets with distinctly serrated margins; B, Kidney-shaped stipule-like structures inserted near the base of the densely tomentose leaf stalks. Scale bar = 3 cm [A]; 1 cm [B].

2. *Canarium patentinervium* Miq.

(Latin *patens*, spreading; *nervus*, nerves; referring to the widely-spaced secondary veins on the leaflet blade below)

Key references. Leenhouts (1956: 258–259); Leenhouts (1959: 342–343); Kochummen (1972: 134); Kochummen (1995: 61).

Medium- to large-sized tree, 12–40 m tall; trunk diameter to 0.2–0.5 m. **Bark** grey-white or grey-brown, with a strong mango- or turpentine-like smell when slashed, smooth to cracking, with many small lenticels, inner bark red or reddish brown, loosely fibrous and with droplets of clear resinous exudate, sapwood whitish. **Twigs** brownish, sometimes lenticellate. **Leaves:** leaf stalks glabrous to sparsely pubescent, *stipule-like structures caducous or sub-persistent, more-or-less on base of leaf stalk, oval to kidney-shaped*. Leaflets 5–11, blade drying dark reddish brown, ovate to oblong-lanceolate, 4.0–21.0 × 1.5–7.5 cm, coriaceous, upper and low surfaces glabrous, *secondary veins 5–15 pairs, widely spaced, distinctly arching or looping at some distance from the margin, tertiary veins reticulate, inconspicuous, midrib grooved or flattened above, especially towards the base*, apex acuminate, margin entire, base broadly cuneate; leaflet stalks slightly swollen at both ends. **Inflorescence** terminal, male sparsely tomentose and many-flowered, female densely tomentose and fewer-flowered. **Fruit** ellipsoid to obovoid, round to rounded-triangular in cross section, 3.0–6.0 × 1.0–2.0 cm.—Fig. 2.

Singapore localities. Previously collected from Bukit Timah (H. N. Ridley 8401; J. S. Goodenough s.n. SING barcode number 0004117; Mohd. Noor MN 347, 969, 1317, & 1420; Ngadiman SFN 36400; Yassin SFN 36405), Bukit Mandai (H. N. Ridley 6010), Changi (H. N. Ridley 4584, 4729, 4734, & 5981; J. S. Goodenough 1868) and Sungei Morai (J. S. Goodenough 3799). Recently collected from Bukit Timah (A. T. Gwee SING 2010-050), Chestnut Area (A. T. Gwee SING 2010-584), and MacRitchie Reservoir (A. T. Gwee SING 2009-655).

Habitat. We collected one specimen of this species from the dry areas of the NSSF. According to Leenhouts (1959: 341), this species is found in primary forests to 450 m, rarely up to 1,150 m.

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

Suggested common name. fragrant kenari.

Remarks. The specimen, consisting only of fallen leaflets collected from the Nee Soon Swamp Forest (A. Samsuri, S. K. Ganesan, P. Leong, A. T. Gwee, and Mohd. Noor NES 164), does not match other specimens of this species collected from the BTNR and CCNR. It has most likely been wrongly determined.

3. *Canarium pilosum* Benn. ssp. *pilosum*

(Latin *pilosus*, hairy, referring to the long soft hairs on the twigs and leaflets)

Key references. Leenhouts (1956: 281–282); Leenhouts (1959: 398–401); Kochummen (1972: 134–135); Kochummen (1995: 61–62).

Small to medium-sized tree approximately 10–28 m tall, rarely to 37 m tall; trunk diameter 0.2–0.45 m, rarely to 0.65 m. **Bark** grey-white or grey-brown, smooth, lenticellate, inner bark pink to brown, laminated, sapwood white. **Twigs** densely pilose to rarely glabrous. **Leaves:** leaf stalks densely pilose to rarely glabrous, *stipule-like structures usually persistent, sometimes absent, some distance away or more-or-less on base of leaf stalk, subulate to awl-shaped*. Leaflets 5–9, blade drying yellowish or greenish to greenish brown, ovate to oblong-lanceolate, 4.0–16.5 × 2.0–6.5 cm, chartaceous, upper surface glabrous to sparsely pilose, lower surface usually densely pilose, especially on secondary veins and midrib, to rarely glabrous, secondary veins 8–15 pairs, arching at margin, tertiary veins scalariform-reticulate, midrib raised above, apex variable, acute to acuminate, *margin minutely serrated to rarely entire*, base rounded to broadly cuneate; leaflet stalks densely pilose to rarely glabrous. **Inflorescence** axillary to pseudo-terminal or rarely terminal, sparsely to densely pilose. **Fruit** oblong to ovoid or ellipsoid to fusiform, rounded-triangular in cross section, 2.0–3.0 × 1.0–1.5 cm.—Fig. 3.

Singapore localities. Nee Soon Swamp Forest (A. T. Gwee & P. T. Chew et al. SING 2009-129). Previously collected from Bukit Timah (J. F. Maxwell 82-62; Mohd. Noor MN 636 & MN 1110; Ngadiman SFN 36420 & SFN34995), Bukit Kallang (J. F. Maxwell 83-16), Changi (H. N. Ridley 4654), Jurong (E. J. H. Corner SFN 26197; I. H. Burkill 1284), MacRitchie Reservoir (E. J. H. Corner SFN 36135), Mandai Road (E. J. H. Corner SFN 33142 & SFN 37130), Reservoir Woods (H. N. Ridley 12570) and Seletar Reservoir (J. Sinclair SFN 39996). Recently collected from Mandai (A. T. Gwee SING 2010-193) and Seletar Track (A. T. Gwee, P. T. Chew, & Ali Ibrahim et al. SING 2008-530).

Habitat. Found in both dry and swampy areas. According to Leenhouts (1959: 401), this species is found in primary forests and in swamps, to 350 m and rarely up to 1,250 m.

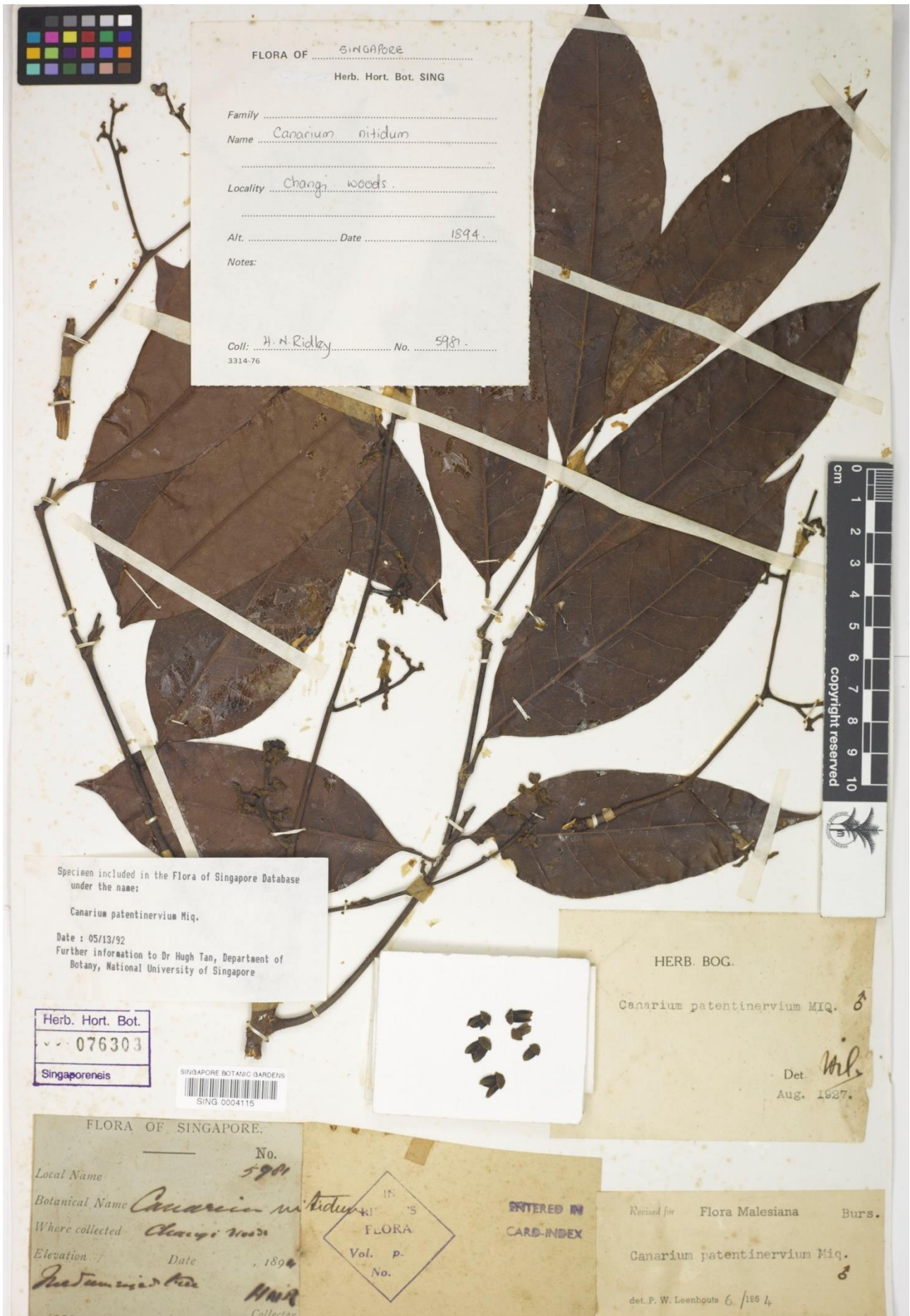


Fig. 2. Herbarium specimen of *Canarium patentinervium* showing the widely spaced secondary veins. H.N. Ridley 5981, Changi Woods, SING barcode no. 0004115.



Fig. 3. *Canarium pilosum* ssp. *pilosum*. A, Leaflets; B, Hairs (up to 5 mm long) on the rachises, leaflet stalks and lower surfaces of the leaflets; C, Leaflets showing distinctly serrated margins with hairs (up to 5 mm long); D, Twig and leaf stalks showing reddish brown hairs and linear to awl-shaped stipule-like structures; E, Close up of the pair of linear to awl-shaped stipule-like structure inserted at the base of the petiole. Scale bar = 2 cm [B]; 1 cm [C, D, E].

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

Suggested common name. hairy-leafed kenari.

Remarks. Leenhouts (1959: 401) described this species as being rather variable. He also recognised two subspecies, ssp. *pilosum* and ssp. *borneensis* Leenh., but only the former has been recorded from the Malay Peninsula.

DACRYODES Vahl

(Greek *dakruon*, a tear, referring to the resin droplets on the bark surface)

Small- to medium-sized, buttressed tree. **Leaves:** spiral; stipule-like structures absent. **Inflorescences** in axillary and/or terminal panicles. **Flowers** unisexual, 3-merous, receptacle flat. **Fruit** a drupe, oblong or ellipsoid, stigma more-or-less apical.

1. *Dacryodes costata* (Benn.) Lam

(Latin *costatus*, ribbed, probably referring to the prominent veins on the leaflet blade below)

Key references. Kalkman (1954: 508–509); Leenhouts (1956: 222–223); Kochummen (1972: 140); Kochummen (1995: 66–67).

Medium to large-sized tree, 20–30 m tall, rarely to 40 m tall; trunk diameter 0.2–1 m; rarely with buttresses. **Bark** silvery grey-brown, smooth to scaly or flaky, with abundant small lenticels, inner bark yellow-brown, strongly aromatic, mango- or turpentine-like smell, mottled to laminated, with droplets of clear to white resinous exudate, sapwood white to yellowish white. **Twigs** yellowish-brown, pubescent. **Leaves:** leaf stalks strongly flattened at base, distinctly pubescent; leaflets 3–9, blade drying greyish brown, broadly elliptic to oblong, 8.5–17.5 × 3.0–7.0 cm, rigidly chartaceous to sub-coriaceous, upper surface shiny, lower surface usually glabrous, sometimes with slightly pubescent midrib and secondary veins, secondary veins 6–13 pairs, usually strongly curving, apical ones arching, prominent below, tertiary veins reticulate, midrib raised above, apex abruptly, shortly and bluntly acuminate, base broadly cuneate to rounded, hardly oblique; leaflet stalks swollen at both ends. **Inflorescence** terminal or rarely axillary, densely pubescent. **Fruit** ellipsoid or ovoid, 1.2–1.9 × 0.8–1.2 cm, apex more-or-less obtusely acute, base rounded.—Fig. 4.

Singapore localities. Previously recorded from NSSF in Wong (1993) and Wong et al. (1994), but no specimens collected from NSSF were found in SING at the time of writing. Previously collected from Bukit Timah (Mohd. Noor MN 1319 & MN 1373; Ngadiman SFN 36477). Recently collected from Bukit Timah (A. T. Gwee SING 2010-408) and Chestnut Area (A. T. Gwee 2010-528 & SING 2010-711).

Habitat. According to Leenhouts (1956: 222), this species is found in primary forest usually to 100 m, rarely up to 500 m altitude.

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

Suggested common name. ribbed-leafed dacryodes.

Similar species. The sterile specimens of this species may sometimes be difficult to tell apart from those of *Dacryodes rugosa*, according to Kalkman (1954: 509), Leenhouts (1956: 223) and Kochummen (1972: 140). A notable characteristic of this species is its leaf stalks that are strongly flattened at the base.

2. *Dacryodes incurvata* (Engl.) Lam

(Latin *incurvatus*, bending inwards or incurved, referring to the margin of the leaflet blades)

Key references. Kalkman (1954: 506–508); Leenhouts (1956: 224–225); Kochummen (1972: 140–141); Kochummen (1995: 68).

Small- to medium-sized tree, 10–30 m tall; trunk diameter to 0.25–1 m; buttresses sharp, to 2 m tall. **Bark** grey or grey-brown, smooth to scaly or dimpled, with many small lenticels, sometimes with droplets of dark brown resin, outer bark brittle, inner bark yellow or yellowish brown, mottled or laminated, with droplets of white resinous exudate, sapwood pale white to yellowish-brown. **Twigs** dark brown, sparsely pubescent to glabrous. **Leaves:** leaf stalks strongly flattened at base, sparsely pubescent to glabrous; leaflets usually 5–7, blade drying brownish, oblong lanceolate to oblong ovate, 16.0–25.0 × 6.0–8.5 cm, sub-coriaceous to coriaceous, secondary veins 11–17 pairs, nearly right angled to the midrib, especially at the base, curving abruptly, arching and frequently joining near the margin, prominently raised below, tertiary veins reticulate to irregularly transverse, visible but not prominently raised below, midrib raised above, apex abruptly and bluntly acuminate, margin usually slightly incurved, base rounded or cuneate; leaflet stalks swollen at both ends, never dry blackish. **Inflorescence** terminal or sometimes axillary, pubescent. **Fruit** drying light brown and wrinkled, ripening yellow to purplish, ovoid or ellipsoid, 1.5–2.0 × 1.0–1.5 cm, apex pointed, base rounded.

Singapore localities. Previously collected from Mandai Road (S. Kiah s.n. SING barcode number 0053970) only once, the specimen was originally identified as *Santiria laevigata* but was later re-determined to be *Dacryodes incurvata* by K. M. Kochummen.

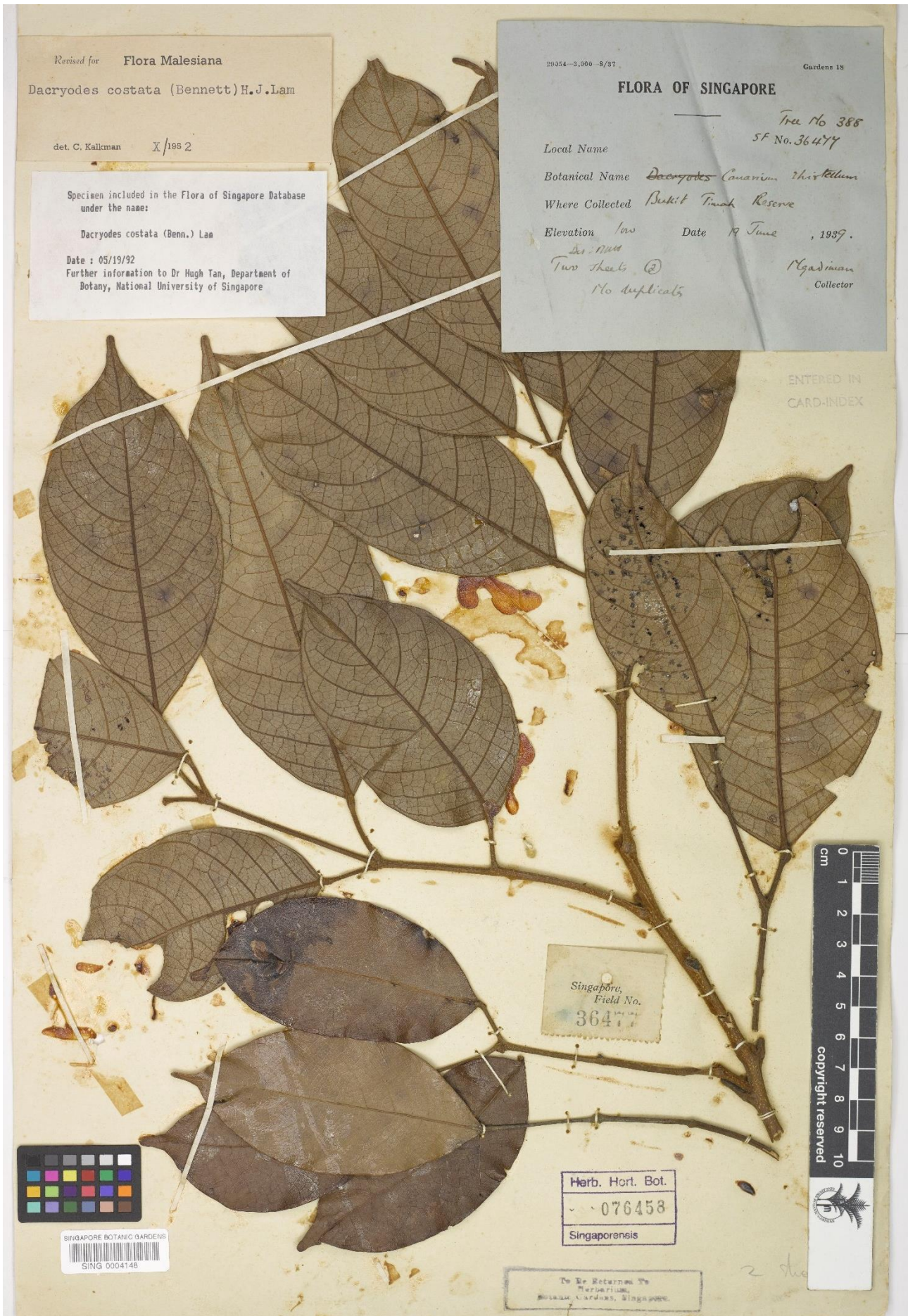


Fig. 4. Herbarium specimen of *Dacryodes costata* showing distinctly pubescent leaf stalks. I. Ngadiman SFN 36477, Bukit Timah Reserve, SING barcode no. 0004148.



Fig. 5. *Dacryodes incurvata*. A, Upper surface of the leaflet; B, Lower surface of the leaflet showing secondary veins that are nearly right angled to the midrib; C, Apical portion of the twig showing a terminal bud that is not covered in resin and leaf stalks that are swollen at the base. Scale bar = 3 cm [A]; 2 cm [B]; 1 cm [C].

Habitat. We collected one specimen of this species from a swampy area. According to Kalkman (1954: 508), this species is found in primary forests and sometimes in swamps, nearly always to 100 m altitude only, rarely otherwise.

Conservation. This species is an overlooked record and hence is not yet assessed.

Suggested common name. incurved-leaved dacryodes.

Similar species. The sterile specimens of this species bear a resemblance to *Santiria laevigata* owing to the secondary veins, which extend nearly right-angled to the midrib. This species differs from the other by its leaflet margins that are frequently incurved, terminal buds that are never covered in resin and leaflet stalks that never dry blackish at both ends.

3. *Dacryodes rostrata* (Bl.) Lam aff. f. *rostrata*
(Latin *rostratus*, beaked, referring to the apex of the leaflet blades)

Key references. Kalkman (1954: 519–521); Leenhouts (1956: 225–226); Kochummen (1972: 143); Kochummen (1995: 72–73).

Small- to medium-, rarely large-sized tree, 5–25 m tall, rarely to 35 m tall; trunk diameter 0.2–0.5 m, rarely to 1.2 m; buttresses sometimes present, small, steep. **Bark** grey or grey-brown, smooth to cracking or scaly, lenticellate, occasionally with smears of black resinous exudate, outer bark grey, hard, inner bark pinkish to red, rarely yellowish white, mottled, with droplets of clear to white resinous exudate, sapwood white. **Twigs** dark brown, lenticellate, glabrous or rusty brown pubescent, especially towards tips. **Leaves:** leaf stalks strongly flattened at base; leaflets 7–13, blade drying reddish brown or dark brown, elliptic-oblong, 4.5–20.5 × 2.0–6.5 cm, chartaceous to coriaceous, secondary veins 7–11 pairs, strongly curving, prominent below, tertiary veins reticulate, minute, visible above and below, midrib raised above and below, *apex bluntly acuminate, sometimes with a long, broadened, blunt tip to 1.0–3.0 cm long*, base often very oblique, one half cuneate, the other half rounded; leaflet stalks strongly swollen at both ends. **Inflorescence** axillary, sometimes pseudo-terminal. **Fruit** drying light greyish brown, ovoid to oblong, 1.5–4.0 × 1.0–2.0 cm, apex slightly contracted.—Fig. 6.



Fig. 6. Herbarium specimen of *Dacryodes rostrata* showing the acuminate apex with a long, broadened, blunt tip. I. Ngadiman SFN 37704, Bukit Timah Reserve, SING barcode no. 0004156.

Singapore localities. Chan Chu Kang (H. N. Ridley 6786). Previously collected from Bukit Timah (H. N. Ridley 6359; Mohd. Noor MN 1213 & MN 1442; Ngadiman SFN 36458, SFN 36484, SFN37704, & SFN 37038), Changi (J. S. Goodenough s.n. SING barcode number 0004167) and Mandai Road (Liew SFN 37743). Recently collected from Bukit Timah (A. T. Gwee SING 2010-074; H. K. Lua SING 2014-197; T. M. Leong SING 2009-417), Chestnut Area (A. T. Gwee SING 2010-519), and Mandai (A. T. Gwee et al. SING 2008-492).

Habitat. Found in both dry and swampy areas. According to Leenhouts (1956: 226), this species is found in primary or sometimes secondary forests, up to 600 m altitude. It is also rarely found in swamps.

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

Remarks. Kochummen (1972: 143) observed that the saplings of this species produce a white resinous exudate from their cut bark. We observed that the seedlings of this species have leaflets that dry reddish brown and have broadly ovate blades, a chartaceous texture, long and blunt tips at the apex as well as longer and thinner leaflet stalks.

Additional remarks. Kalkman (1954: 519) and Leenhouts (1956: 226) both described this species as extremely polymorphous and therefore difficult to delimit into distinct forms. However, Kalkman (1954: 519) recognised four forms based on the subdivision of Lam (1932). Amongst these forms, specimens from the NSSF are comparable to the typical form, f. *rostrata*. It is also the only form that has been recorded to be found in the Malay Peninsula.

4. *Dacryodes rugosa* (Bl.) Lam var. *rugosa*
(Latin *rugosus*, wrinkled, referring to the bullate leaflet blades)

Key references. Kalkman (1954: 505–506); Leenhouts (1956: 221–222); Kochummen (1972: 144); Kochummen (1995: 74).

Small- to medium-sized tree, 5–20 m tall, rarely to 35 m tall; trunk diameter 0.1–0.4 m, rarely to 1 m. **Bark** greenish or greenish grey, smooth to flaky or scaly, with a few large lenticels, inner bark pale yellowish-orange, strongly aromatic, mango- or turpentine-like smell, mottled, sapwood white. **Twigs** fawn, with thin papery outer bark and abundant small lenticels. **Leaves:** leaf stalks fawn, strongly swollen at base, with many small lenticels; leaflets 5–7, blade drying greenish, rarely brownish, obovate to oblong-lanceolate, 5.5–15.0 × 2.0–5.5 cm, chartaceous, upper surface shiny, bullate, secondary veins 7–10 pairs, slightly curving, often arching near margin, prominent and raised below, tertiary veins reticulate, prominent and raised below, midrib raised above, apex typically abruptly acuminate, sometimes with a long, slightly broadened tip to 0.5–3.5 cm, base oblique, cuneate to rounded; leaflet stalks strongly swollen at both ends. **Inflorescence** axillary, rarely terminal. **Fruit** ovoid, slightly oblique, 1.5–2.5 × 0.5–1.5 cm.—Fig. 7.

Singapore localities. Previously recorded in Wong et al. (1994), but no specimens collected from the NSSF were found in SING at the time of writing. Previously collected from Bukit Timah Nature Reserve (Mohd. Shah & A. Samsuri MS 3893). It was also recently collected from Bukit Timah (P. Leong SING 2014-197).

Habitat. Found in both dry and swampy areas. According to Leenhouts (1956: 222), this species is found in primary forests up to 900 m altitude.

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

Suggested common name. puckered-leafed dacryodes.

Similar species. The sterile specimens of this species may sometimes be difficult to tell apart from the sterile specimens of *Dacryodes costata* according to Kalkman (1954: 505), Leenhouts (1956: 222), and Kochummen (1972: 144). A notable characteristic of this species is its leaf stalks that are strongly swollen at the base. Kalkman (1954: 505–506), Leenhouts (1956: 222) and Kochummen (1995: 74) recognised two varieties, namely: var. *rugosa* and var. *virgata* (Bl.) Lam. However, only the former has been recorded in the Malay Peninsula.

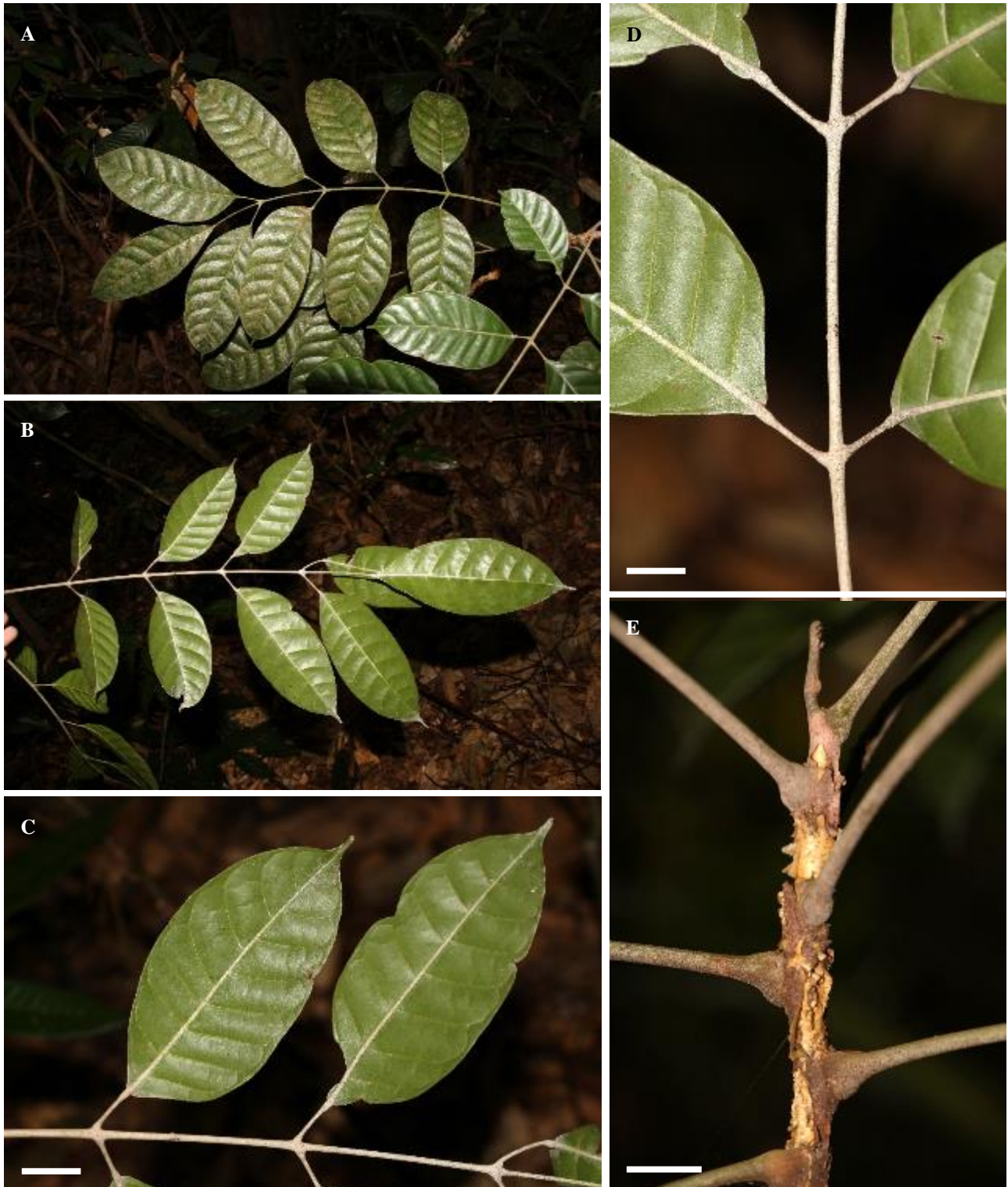


Fig. 7. *Dacryodes rugosa* var. *rugosa*. A, Upper surfaces of the leaflets, bullate; B, Lower surfaces of the leaflets; C, Close up of the lower surfaces of the leaflets showing the long and slightly broadened tip; D, Leaflet stalks that are strongly swollen at both ends; E, Apical portion of the twig showing thin papery outer bark. Scale bar = 2 cm [C, E]; 1 cm [D].

SANTIRIA Bl.

(Santir—Carl Ludwig Blume’s native guide to Gunung Salak, Java)

Medium- to large-sized, buttressed tree. **Leaves** spiral, stipule-like structures absent. **Inflorescences** usually in axillary panicles, rarely in terminal panicles. **Flowers** unisexual, 3-merous, receptacle flat. **Fruit** a drupe, irregularly globose or ellipsoid, more-or-less oblique, usually seated on the persistent calyx, stigma often excentric.

1. *Santiria apiculata* Benn. var. *apiculata*

(Latin, *apiculatus*, pointed, referring to the apex of the leaflet blades)

Key references. Kalkman (1954: 538–539); Leenhouts (1956: 234–236); Kochummen (1972: 146); Kochummen (1995: 85–86).

Small- to medium-sized tree, 6–20 m tall, rarely to 40 m tall; trunk diameter 0.3–0.6 m, rarely to 1 m; buttresses short. **Bark** grey or brown, smooth to rough or flaky, inner bark cream to pink, strongly aromatic, mango- or turpentine-like smell, with droplets of white resinous exudates, sapwood whitish. **Twigs whitish.** **Leaves:** leaf stalks whitish, hardly flattened at base; leaflets 3–9, rarely simple, blade drying greenish to greenish yellow or dull above, ovate to elliptic, 5.0–15.0 × 2.0–6.5 cm, subcoriaceous, secondary veins 6–14 pairs, arching, appearing yellowish below when dry, tertiary veins reticulate, inconspicuous above, visible below, midrib raised or flattened above, striated and appearing yellowish below when dry, apex typically abruptly acuminate, base oblique or rounded to cuneate; leaflet stalks whitish. **Inflorescence** axillary, very rarely pseudo-terminal. **Fruit** green to yellowish when young, turning red and then purplish black when mature, round to ellipsoid, very oblique, 0.8–1.8 × 0.6–1.3 cm.—Fig. 8.

Singapore localities. Nee Soon Swamp Forest (A. Samsuri, S. K. Ganesan, S. Lee, P. Leong, A. T. Gwee, & G. Chua NES 334) and “Selitar” (H. N. Ridley 6139). Previously collected from Bajau (H. N. Ridley 6361), Bukit Timah (A. Samsuri SA 1221; Castawi 11372; H. N. Ridley 6207, 6362 & 13525; I. H. Burkill SFN 2027; J. F. Maxwell 81-97; Mohd. Shah & A. Samsuri MS 3900; Yassin SFN 36413), Bukit Mandai (Mat 6787), Kranji (Unknown 6556), and Mandai Road (Kiah s.n. SING barcode number 0004169). Recently collected from Bukit Batok Nature Reserve (H. K. Lua SING 2014-105), Bukit Timah Nature Reserve (S. Teo SING 2005-91), MacRitchie Reservoir (A. T. Gwee SING 2009-640; H. K. Lua SING 2014-205), and Upper Pierce (A. T. Gwee SING 2009-692).

Habitat. Found more often in swampy than dry areas. According to Leenhouts (1956: 234), this species is found in primary forest, on dry ground and more rarely on swampy soil, usually at low altitudes, rarely to 1,200 m altitude.

Conservation. Not threatened.

Suggested common name. pointed-leafed santiria.



Fig. 8. *Santiria apiculata* var. *apiculata*. A, Leaflets; B, Close up of leaflets showing whitish leaflet stalks and rachis; C, Close up of whitish twigs and leaf stalk. Scale bars = 1 cm.

Remarks. Leenhouts (1956: 234) recognised three varieties: var. *apiculata*, var. *rubra* (Ridl.) Kalkman and var. *pilosa* (Engl.) Kalkman. However, only the first two varieties have been recorded from the Malay Peninsula. Kochummen (1972: 146) also recognised the two varieties in the Malay Peninsula. A key for distinguishing the varieties is provided below:

1. Twigs whitish; leaflet blade drying greenish to greenish yellow above *Santiria apiculata* var. *apiculata*
 Twigs brownish; leaflet blade drying brownish or greyish above *Santiria apiculata* var. *rubra*

2. *Santiria griffithii* (Hook.f.) Engl.
 (W. Griffith, 1810–45, surgeon at Malacca)

Key references. Kalkman (1954: 545–546); Leenhouts (1956: 236); Kochummen (1972: 147); Kochummen (1995: 88).

Small- to medium-sized tree, 12–35 m tall, rarely to 45 m tall; trunk diameter 0.5–0.8 m, rarely to 1.2 m; buttresses present. **Bark** pale, greenish grey or greenish brown, smooth to scaly, with many medium-sized round or star-shaped lenticels, outer bark deep red to pale pink when scraped, thin and papery, inner bark yellowish white, with droplets of pale or black, sticky resinous exudates, sapwood cream, hard. **Twigs** lenticellate, sometimes pubescent on young parts. **Leaves:** leaf stalks terete or hardly flattened at base, slightly pubescent; leaflets 8–15, not strictly opposite, blade drying greenish brown or brownish, elliptic-lanceolate to oblong-lanceolate, 3.0–14.0 × 1.3–3.7 cm, subcoriaceous, *secondary veins (8–)11–18 pairs, extending from the midrib at nearly right angles or sometimes at an angle to midrib*, distinctly arching near the margin, inconspicuous above, slightly raised below, usually pubescent, intermediate veins distinct and extending almost parallel to the secondary veins, halfway or reaching to the margin, tertiary veins faintly reticulate, *midrib flattened to slightly sunken above*, pubescent below, apex acuminate to rounded, margin sometimes incurved, *base usually symmetrical, rounded or cuneate*. **Inflorescence** axillary, densely to minutely pubescent. **Fruit** ripening blue, obliquely globose, 0.9–1.1 × 0.6–1.0 cm, stigma off centre, calyx persistent.—Fig. 9.

Singapore localities. Nee Soon Swamp Forest (A. Samsuri NES 74) and “Selitar” (Mat 6360). Previously collected from Bukit Timah (E. J. H. Corner SFN 34872; Mohd. Noor MN 956; Ngadiman SFN 34962), Grange Road (H. N. Ridley 10363), MacRitchie Reservoir (E. J. H. Corner s.n. SING barcode number 0004209), and Mandai Road (E. J. H. Corner SFN 34904).

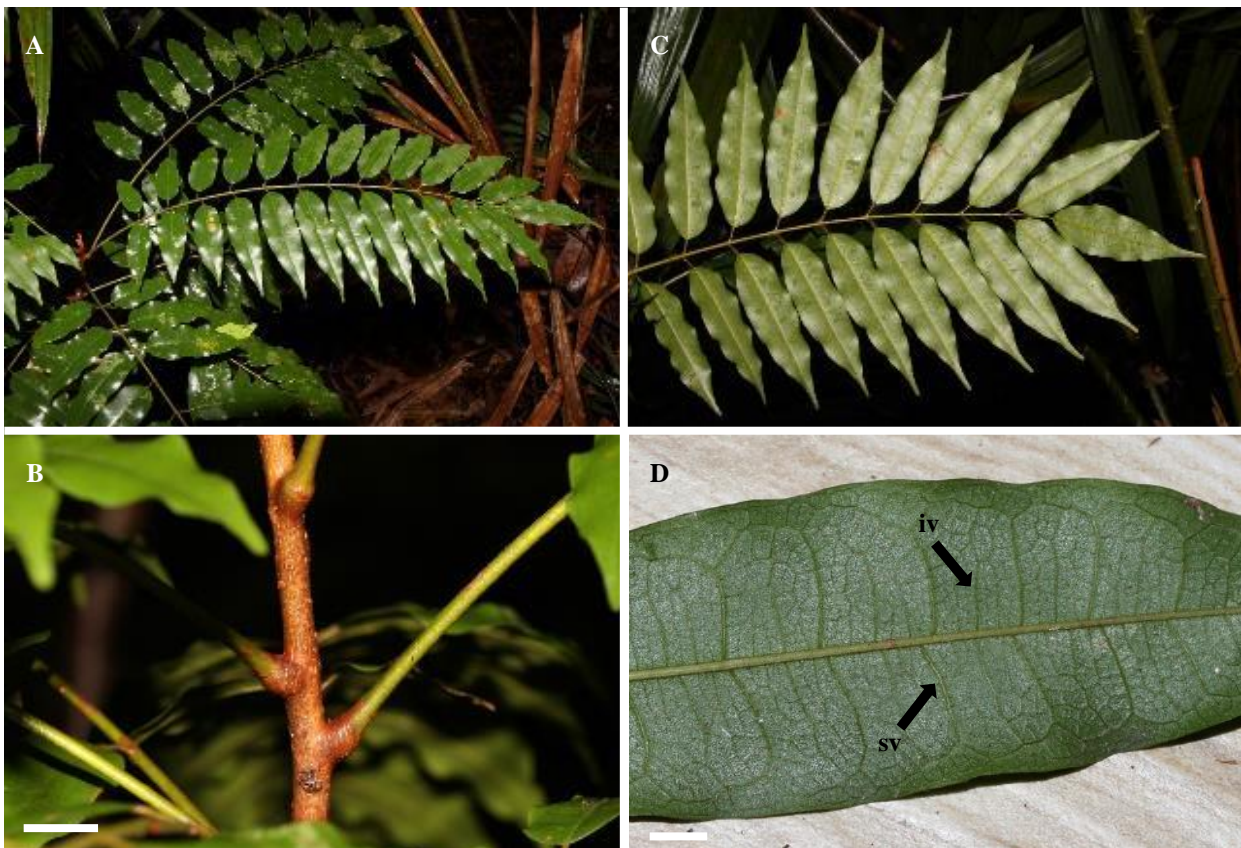


Fig. 9. *Santiria griffithii*. A, Upper surfaces of the leaflets; B, Lenticellate twig; C, Lower surfaces of the leaflets; D, Close up of the lower surface of a leaflet showing secondary veins (sv) that extend from the mid rib at nearly right angles (or sometimes at an angle instead) and intermediate veins (iv) that extend almost parallel to the secondary veins, halfway or reaching to the margin. Scale bar = 2 cm [B]; 0.5 cm [D].

Habitat. Found in both dry and swampy areas. According to Leenhouts (1956: 236), this species is found in primary and secondary forests on dry soils, rarely on swampy soils, up to 300 m altitude.

Conservation. Not threatened.

Suggested common name. Griffith's santiria.

Similar species. The sterile specimens of this species may sometimes be difficult to tell apart from the sterile specimens of *Santiria rubiginosa* according to Kalkman (1954: 546), Leenhouts (1956: 236) and Kochummen (1972: 147). This species may be distinguished from the other by the symmetrical bases of the leaflet blades and the flattened or slightly sunken pubescent midrib above. This species also usually has more pairs of smaller leaflets.

Remarks. Kochummen (1972: 147) observed that the seedlings of this species have at first simple leaves then trifoliate leaves followed by paripinnate leaves. In addition, the leaflets have ovate blades with a thinly chartaceous texture and glabrous surfaces.

3. *Santiria laevigata* Bl.

(Latin, *laevigatus*, smooth and polished, referring to the leaflet blades)

Key references. Kalkman (1954: 535–536); Leenhouts (1956: 232–233); Kochummen (1972: 147–150); Kochummen (1995: 89–90).

Medium- to large-sized tree, 15–30 m tall, rarely to 60 m tall; trunk diameter 0.25–0.7 m, rarely more than 1 m; buttresses often present. **Bark** rusty red, fawn or grey, flaking, with many small or a few large pale brown, corky, round lenticels, outer bark light brown, thin, inner bark pink to brownish pink, strongly aromatic, mango-like or turpentine smell, with droplets of clear or sometimes creamy white sticky resinous exudates, sapwood brownish pink. **Twigs** with small brown lenticels, usually glabrous, sometimes pubescent especially towards tips, *terminal bud 0.5–2.5 cm long, usually covered with resin*, often drying black and shiny. **Leaves:** *leaf stalks strongly channelled above, sharply edged at base*, glabrous to sparsely pubescent; leaflets 5–11, blade drying brown or dark brown, elliptic to oblong, 5.0–26.6(–35.5) × 3.0–10.0 cm, coriaceous, secondary veins 12–20 pairs, nearly right angled to the midrib, especially when mature, sometimes less so when young, often curving or arching to almost looping at margin, tertiary veins reticulate, clearly visible above and below, midrib raised above, apex acute or acuminate, base rounded to cuneate, sometimes oblique; *leaflet stalks slightly swollen at both ends, often drying blackish at both ends*. **Inflorescence** axillary, pubescent when young. **Fruit** obliquely globular, one side flattened, 1.0–1.6 × 0.9–1.5 cm, stigma off centre.—Fig. 10.

Singapore localities. “Selitar” (H. N. Ridley 6188). Previously collected from Bukit Timah (E. J. H. Corner s.n. SING barcode number 0004225; H. N. Ridley 6358; Hamzah Tambi H 2; M. R. Henderson SFN 34790; Ngadiman SFN 34772 & SFN 36130) and “C. C. Kang” (Mat 6784). Recently collected from Bukit Timah (A. T. Gwee SING 2010-094; C M. Boo & P. T. Chew 2014-07-22-003), MacRitchie Reservoir (A. T. Gwee SING 2009-776 & SING 2010-369), and Mandai (A. T. Gwee SING 2010-166).

Habitat. Found in both dry and swampy areas. According to Leenhouts (1956: 232), this species is found in forests, up to 1,200–1,500 m altitude. It is also sometimes found in lowland peat swamp forests, especially for f. *glabrifolia* (Engl.) Lam.

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

Suggested common name. smooth-leafed santiria.

Similar species. The sterile specimens of this species bear a resemblance to *Dacryodes incurvata* owing to the secondary veins that extend nearly right angled to the midrib. This species differs from the other by its leaflet blade margins that are not usually incurved, terminal buds that are usually covered in resin and leaflet stalks that often dry blackish at both ends.

Remarks. Kalkman (1954: 535), Leenhouts (1956: 232–233), and Kochummen (1972: 147–150) recognised two forms: f. *laevigata* and f. *glabrifolia*. The two forms are very similar in vegetative characters, differing mainly in whether their leaf stalks are strongly flattened (in f. *laevigata*) or terete (in f. *glabrifolia*) and are both recorded in Singapore. Therefore, there are difficulties in distinguishing the two forms.



Fig. 10. Herbarium specimen of *Santiria laevigata* showing the resinous terminal bud, leaf stalks that dry black on both ends and distinctive secondary veins. I. Ngadlman SFN 34772, Bukit Timah Reserve, SING barcode no. 0004228.

4. *Santiria rubiginosa* Bl. var. *rubiginosa*

(Latin, *rubiginosus*, rusty, referring to the hairs on the twigs and leaves)

Key references. Kalkman (1954: 542–545); Leenhouts (1956: 237–238); Kochummen (1972: 151); Kochummen (1995: 94).

Medium-sized tree to 20 m tall, rarely to 45 m tall; trunk diameter to 0.65 m; buttresses tall or small and spreading. **Bark** yellowish grey or fawn, smooth to rough, slightly scaly or dimpled, with some small lenticels, inner bark orange-white, aromatic, mango- or turpentine-like smell, mottled, with droplets of clear whitish resinous exudates, sapwood light yellow to cream. **Twigs** sometimes sparsely pubescent toward tips. **Leaves:** leaf stalks rounded or hardly flattened at base, sparsely pubescent; leaflets 5–13, blade drying brownish, rarely greenish above, elliptic or ovate to oblong-lanceolate, 4.0–15.0 × 1.5–5.5 cm, subcoriaceous, *secondary veins (7–)10–14 pairs, extending straight at an angle to the midrib, forking or less distinctly arching near the margin, intermediate veins distinct and extending almost parallel to the secondary veins, halfway or reaching to the margin, tertiary veins faintly reticulate, midrib ridged, raised or flattened above*, sometimes sparsely pubescent below, apex bluntly to sharply acuminate, sometimes with a tip up to 3.0 cm long, *base usually asymmetrical, cuneate*. **Inflorescence** axillary, sparsely pubescent, without or with (especially for female ones) a short peduncle. **Fruit** yellow to red mauvish-blue to black, oblique, irregularly globular or ellipsoid, 0.8–1.3 × 0.7–0.9 cm, stigma less than 90° off centre.—Fig. 11.

Singapore localities. Nee Soon Swamp Forest (A. T. Gwee SING 2010-391; A. Samsuri, S. K. Ganesan, S. Lee, P. Leong, A. T. Gwee and Mohd. Noor NES 278 & A. Samsuri, S. K. Ganesan, S. Lee, P. Leong and A. T. Gwee NES 205). Previously collected from Bukit Mandai (J. S. Goodenough 3802), Bukit Timah (E. J. H. Corner SFN 34953 & SFN 34907; Ngadiman SFN 34915; R. D. Hill H 439), Jurong (E. J. H. Corner s.n. SING barcode number 0004239), Mandai Forest (J. Lai LJ 519), Mandai Road (Kiah SFN 37118; Kiah s.n. SING barcode number 0004242; E. J. H. Corner SFN 34903). Recently collected from Seletar Track (A. T. Gwee, P. T. Chew & Ali Ibrahim et al. SING 2008-529).

Habitat. Found in both dry and swampy areas. According to Leenhouts (1956: 238), this species is found in primary forest and sometimes in open localities or on swampy ground, to 600 m altitude.

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

Suggested common name. rusty-leafed santiria.

Similar species. The sterile specimens of this species may often be difficult to tell apart from the sterile specimens of *Santiria griffithii* according to Kalkman (1954: 543), Leenhouts (1956: 237), and Kochummen (1972: 151). This species may be distinguished from the other by the asymmetrical base of the leaflet blades and the ridged or raised, glabrous to puberulent midrib above. This species also usually has fewer pairs of larger leaflets.

Remarks. Our observations correspond with those of Kochummen (1972: 151) that the seedlings of this species have leaflet blades that dry greenish rather than brownish and have a more chartaceous texture than those of the adults. Leenhouts (1956: 237–238) recognised three varieties: var. *rubiginosa*, var. *pedicellata* (Ridl.) Kalkman and var. *nana* (Lam) Kalkman. However, var. *pedicellata* is restricted to Borneo while var. *nana* is more commonly found in peat swamps. The latter is also pilose on both leaflet blade surfaces. Kochummen (1972: 151) recognised a fourth variety: var. *latipetiolata* Kochummen, which is endemic to Sarawak.

5. *Santiria tomentosa* Bl.

(Latin, *tomentosus*, dense covering of hairs that woolly or short, referring to the leaflets)

Key references. Kalkman (1954: 529–530); Leenhouts (1956: 231); Kochummen (1972: 151–152); Kochummen (1995: 95, 97)

Medium-sized tree to 35 m tall; trunk diameter to 0.8 m; buttresses often small and sharp. **Bark** greenish grey, sometimes dark reddish brown where recently exposed, scaly, with many medium to large star-shaped or longitudinal lenticels, outer bark soft, thin, inner bark pinkish red, laminated, with droplets of colourless resinous exudates from cambium, sapwood creamy white to pink. **Twigs** rusty tomentose, terminal bud long, slightly curved, subacute. **Leaves:** leaf stalks flattened to rounded at base, rusty tomentose; leaflets 5–9, blade drying reddish brown above, ovate to oblong, terminal ones sometimes obovate, 7.0–20.0 × 3.5–6.5 cm, coriaceous, upper surface glabrous except for midrib, *lower surface densely woolly tomentose*, secondary veins 18–24 pairs, strongly curving or arching near the margin, inconspicuous above, raised below, tertiary veins transverse, inconspicuous above, raised below, apex gradually to abruptly acuminate, base rounded or one half broadly cuneate; leaflet stalks slightly to densely tomentose. **Inflorescence** axillary, 6–7 in long, densely tomentose. **Fruit** irregularly globose to oblong, 1.0–1.8 × 1.0–1.7 cm, stigma less than 90° off centre.—Fig. 12.

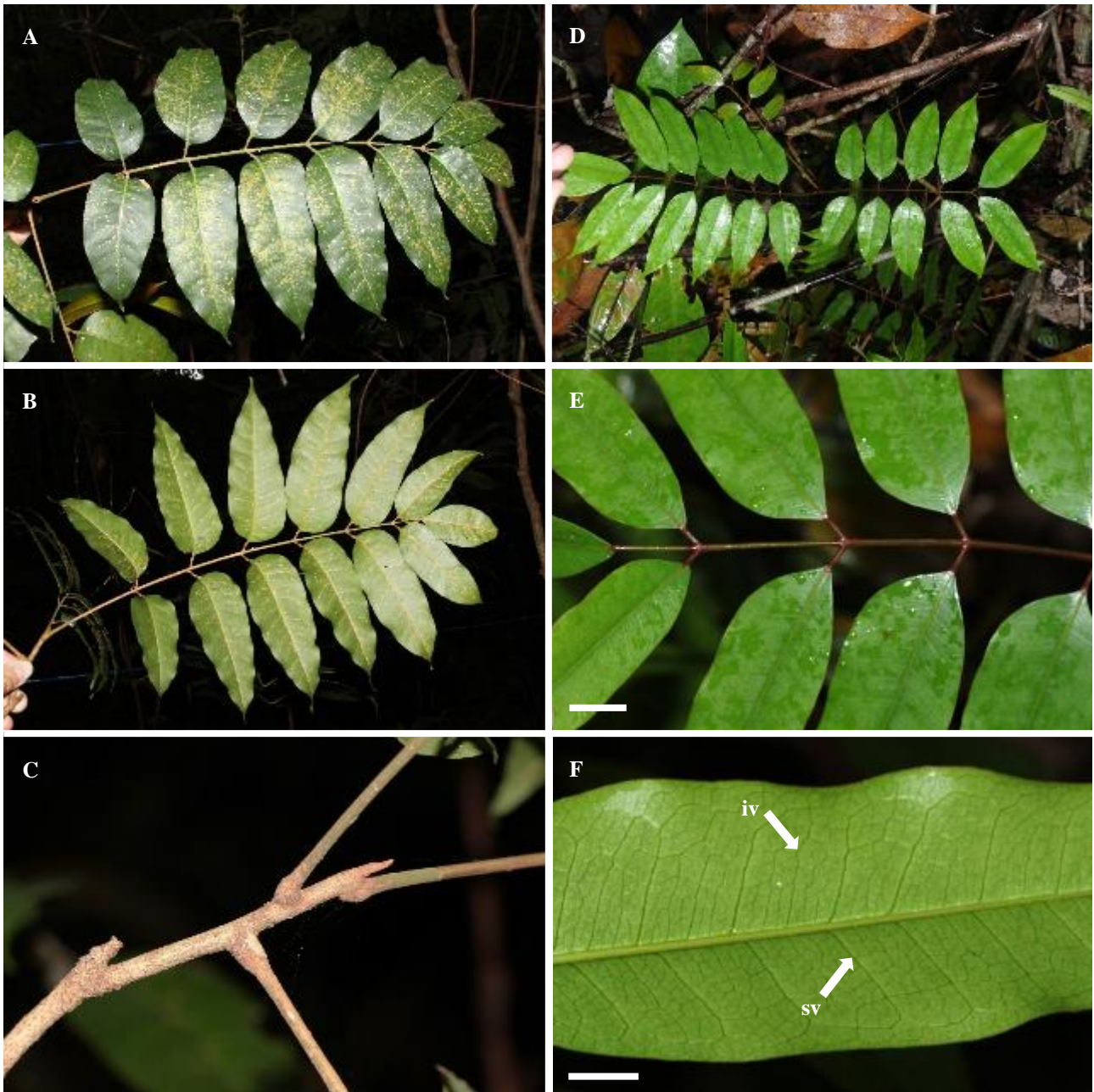


Fig. 11. *Santiria rubiginosa* var. *rubiginosa*. A, Upper surfaces of the leaflets of the mature plant; B, Lower surfaces of the leaflets of the mature plant; C, Apical portion showing sparsely pubescent twig and leaf stalks; D, Sapling; E, Close up showing the asymmetrical base of the leaflets; F, Close up of the lower surface of the leaflets showing secondary veins (sv) that extend straight at an angle to the mid rib and intermediate veins (iv) that extend almost parallel to the secondary veins, halfway or reaching to the margin. Scale bar = 1 cm [E]; 0.5 cm [F].

Singapore localities. “Selitar” (H. N. Ridley 3917). Previously collected from Bukit Timah (Ngadiman SFN 34618), Dalvey Road (Collector unknown SING barcode number 0004260), and MacRitchie Reservoir (E. J. H. Corner SFN 32789).

Habitat. We collected one specimen of this species from a dry area. According to Leenhouts (1956: 231), this species is found in primary forest on dry or swampy ground, sometimes in occasionally flooded areas, at low altitudes, rarely up to 250 m altitude.

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

Suggested common name. woolly-leafed santiria.

Remarks. Kochummen (1995: 97) noted that this species is greatly variable in leaflet size and degree of pubescence.



Fig. 12. *Santiria tomentosa*. A, Upper surfaces of the leaflets; B, Close up of the densely woolly tomentose lower surfaces of the leaflets and leaflet stalks; C, Close up of the glabrous upper surfaces of the leaflet showing the densely tomentose mid ribs. Scale bar = 1 cm.

TRIOMMA Hook.f.

(Greek *tri*, three; *omma*, eyes or openings; referring to the seeds in cross section)

1. *Triomma malaccensis* Hook.f.

(of Malacca)

Key references. Kalkman (1954: 499–500); Leenhouts (1956: 218–219); Kochummen (1972: 154–155); Kochummen (1995: 98, 100).

Large-sized tree to 60 m tall; trunk diameter to 1 m or more; buttresses small to medium. **Bark** greenish grey or brown, sometimes pale or pinkish when freshly exposed, smooth to slightly scaly or dimpled, with a few star-shaped lenticels, inner bark pink or reddish brown, strongly aromatic, mango- or turpentine-like smell, with droplets of colourless resinous exudates, sapwood pale yellow. **Twigs** drying dark, glabrous. **Leaves:** leaf stalks rounded to slightly flattened at base; leaflets 5–9, usually 9, blade drying reddish brown, ovate to oblong, 2.0–15.5 × 1.0–6.5 cm, chartaceous, secondary veins 7–12 pairs, drying pinkish brown, usually slightly curved, arching near apex, conspicuous above and below, tertiary veins reticulate, conspicuous above and below, midrib raised above, apex bluntly acuminate, base strongly asymmetrical, oblique or decurrent, rarely rounded. **Inflorescence** axillary, sometimes appearing pseudo-terminal, much branched from base, densely tomentose, **Fruit** a 3-winged capsule, dehiscent with 3 woody valves, 5.5–7.5 cm long, wings 2.0–2.5 cm broad. **Seeds** 3, with broad membranous wings, apex acuminate, base rounded.—Fig. 13.

Singapore localities. Previously recorded in NSSF by Wong (1993), Wong et al. (1994), and Turner et al. (1996) but no specimens from NSSF were found in SING at the time of writing. Previously collected from Bukit Timah (E. J. H. Corner SFN 34956) and Botanic Gardens Jungle (Hassan 36278).

Habitat. According to Leenhouts (1956: 219), this species is frequently found in old-growth forest and rarely in secondary forest. It is also mostly found on dry ground and rarely in swampy or permanently flooded sites, usually up to 150 m and rarely to 400 m altitude.



Fig. 13. Herbarium specimen of *Triomma malaccensis* showing strongly asymmetrical leaf bases. E.J.H. Corner 34956, Bukit Timah, SING barcode no. 0004263.

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

Suggested common name. Malaccan triomma.

Remarks. Kochummen (1972: 155) observed that the saplings of this species have pubescent leaf stalks, leaflet blades and leaflet stalks.

ACKNOWLEDGEMENTS

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