Old Hats Are Better: New Considerations and Taxonomic Changes in the Southeast Asian *Gardenia tubifera* Complex (Rubiaceae)

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Abstract

Gardenia tubifera sensu Corner is revised over its entire range in Southeast Asia. It is a heterogeneous complex of three distinct taxa, *G. elata* Ridl., *G. subcarinata* (Corner) Y.W.Low (elevated from varietal status) and *G. tubifera* Wall., mainly distinguished by calyx form, fruit size and ecological distribution. Two new varieties are described, *G. elata* var. *longipedicellata* K.M.Wong (from the Philippines) and *G. subcarinata* var. *sumatrana* Y.W.Low (from Sumatra). A key for identification, descriptions, nomenclatural notes, illustrations and exsiccatae examined for all recognised taxa are provided. *Gardenia elata* is lectotypified.

Introduction

Gardenia tubifera Wall. sensu Corner (1939) is a heterogeneous taxon including elements that are small to medium-sized trees occurring in swamps and hill forests. Two varieties were recognised, namely, *G. tubifera* var. *subcarinata* Corner (with a narrowly keeled calyx tube) and *G. tubifera* var. *tubifera* (with a smooth calyx tube). Subsequently, *G. tubifera* var. *tubifera* was further divided (Wong 1982, 1989) into two forms, *G. tubifera* var. *tubifera* forma *tubifera* and *G. tubifera* var. *tubifera* forma *elata* (Ridl.) K.M.Wong.

For the present work, taxonomic treatments by Corner (1939) and Wong (1982, 1989) pertinent to the *G. tubifera* complex were reviewed. This led to the distinctions reported here, including the resurrection of *G. elata* Ridl., a narrower circumscription of *G. tubifera* and the elevation of Corner's *G. tubifera* var. *subcarinata* to species level.

In this study, specimens of *G. tubifera s.l.* from 14 herbaria (A, BKF,

BO, BRUN, IBSC, K, KEP, KLU, L, NY, SAN, SAR, SING and US) were examined. A new variety is proposed for *G. subcarinata* from Sumatra in Indonesia and another new variety for *G. elata* from Luzon in the Philippines. Also, field observations of *G. elata* var. *elata*, *G. subcarinata* var. *subcarinata* and *G. tubifera* were made to complement the findings from the herbarium study.

Characters and species distinctions

Corner (1939) was convinced that *G. tubifera* was a very variable species with regard to leaves, flowers and fruits. He adopted a broad concept for *G. tubifera*, in which he included *G. elata* Ridl., *G. resinifera* Korth. and *G. speciosa* Hook.f. as synonyms. His justification for this was largely based on the calyx tube length, corolla tube length, and diameter across corolla lobes in the open flower, the last of which he referred to as the 'limb' (more precisely, limb span), which overlapped in the several taxa he considered. In reaching this conclusion, Corner had considered earlier distinctions using these characters by Hooker (1880), King and Gamble (1903) and Ridley (1923), using measurements given by these authors, as well as from additional specimens that were available. In so doing, and without the benefit of a broader character survey including more species of *Gardenia*, Corner did not attempt to use other characters for species distinction.

In the same paper, Corner (1939) also named another taxon with keeled calyx tubes as a variety of *G. tubifera.* This taxon had corolla tube length and 'limb span' that also fell within the range accepted by him for *G. tubifera*.

The status of *Gardenia tubifera* var. *subcarinata* Corner

The most general characters that easily distinguish many species of *Gardenia* appear to be those associated with calyx morphology. For example, in Malaysia, there are three species of *Gardenia* with keeled calyces, namely, *G. carinata* Wall., *G. chanii* Y.W.Low and *G. pterocalyx* Valeton. They can be easily differentiated based on the form of the keels, for example, *G. carinata* has keels resembling large triangular wings at the top of the subcylindrical tube; *G. chanii* has keels resembling narrow elongate wings stretching down the length of the tube to the top of the hypanthium only, the tube being widely flared towards its apex; and *G. pterocalyx* has keels resembling narrow elongate wings stretching down both the tube and the hypanthium, the tube tightly ensheathing and not flared-out. The same characters were useful in Hawaii (St. John and Kuykendall, 1949), where two species of *Gardenia* with keeled calyces, *G. mannii* St.John & Kuykendall (keels with

a laterally prolonged, narrowed proximal part ending in a spathulate apical lobe) and *G. remyi* Mann. (keels resembling butterfly wings and without a prolonged, narrowed proximal part), were distinguished.

We have also found that distinctive keel features are useful in recognising individual species in our study. Additionally, there are also consistent differences in other characters. For example, in distinguishing *G. chanii* from *G. pterocalyx* (Low and Wong, 2007), leaf apex shape, domatia type, leaf size, fruit pedicel length and corolla tube length provided consistent differences in addition to calyx keel form. In fact, other than the placement of *G. tubifera* var. *subcarinata* (with a slightly keeled calyx tube that often shows clear marginal lobes) in a taxon that otherwise has a completely smooth and subtruncate calyx tube, Wong (1982, 1989) also distinguished species effectively based on calyx morphology, in particular, the tube and keel form. It is true that a very small number of specimens of typical *G. tubifera* sometimes display faint, rib-like traces along the calyx tubes, but these are never laminate structures protruding from the calyx surface as are keels, as defined here; similarly, dried fruits can be ribbed but not keeled.

We know of no other instances where *Gardenia* species have so great a variation in calyx form to include both smooth (unkeeled) and keeled calyx tubes. In examining the probability that *G. tubifera* var. *subcarinata* has been injudiciously grouped with typical *G. tubifera* (and therefore should be recognised as a distinct species), we searched for other differences between them. As, indeed, a number of such consistent differences exists (Table 1). We conclude that *G. tubifera* var. *subcarinata*, with an easily distinguished calyx form, should be recognised as a distinct species from *G. tubifera*. This is here recognised as *G. subcarinata* (Corner) Y.W.Low *comb. et stat. nov*.

The two forms of *Gardenia tubifera* var. *tubifera* sensu Corner

Notwithstanding the distinctiveness (and usefulness) of calyx morphology in distinguishing taxa, pairs of species with very similar calyx morphology are known to occur that, nevertheless, can be well differentiated by other characters. For example, *G. coronaria* Buch.-Ham. and *G. thailandica* Tirveng. (both in the Myanmar-Thailand area but with overlapping distribution in the isthmus region of the Thai-Malay Peninsula) cannot be distinguished by their calyces as both have membraneous, sheathing calyx tubes with oblique mouths. However, *G. coronaria* has longer corolla tubes (5.6-8.5 cm long) and bigger corolla lobes (3-6 cm long, 2.2-3.4 cm broad), whereas *G. thailandica* has shorter corolla tubes (3-5.8 cm long) and smaller corolla lobes (1.5-2.1 cm long, 1-1.6 cm broad).

Another example is provided by *G. beamanii* Y.W.Low (north and northwest parts of Borneo) and *G. griffithii* Hook.f. (Malay Peninsula,

Sumatra and Borneo), both with long and smooth calyx tubes sheathing the corolla tube and with flared mouths. These species are distinguished by the black dried exudate at shoot tips, puberulent lower leaf surface and longer flower pedicels (0.5-0.8 cm long) of *G. beamanii* and the yellowish amber-brown exudate at shoot tips, short-hairy lower leaf surface and shorter flower pedicels (0.2-0.4 cm long) of the latter species.

We therefore conclude that it is possible for well-differentiated species to share very similar calyx forms, but we wish to highlight that in such cases it should still be possible to find a number of other consistent, easily observable, differences in both vegetative and reproductive parts. In other words, the distinctions between species are not slight or restricted to a single character. Corner (1939) did not emphasize fruit size as a potential species difference, especially in the case of *G. tubifera* sensu stricto (with smaller fruits not exceeding 3 cm across) and *G. elata* (with larger fruits (3-)4-6.5 cm across). We have conducted numerous surveys of these two species in both Peninsular Malaysia and Borneo and find the fruit size difference is highly consistent with other distinguishing features as outlined above (Table 1). In addition, the ecology may also be indicative. *G. tubifera* var. *tubifera* forma *elata* is generally a lowland to hill forest taxon preferring drier sites although they do (more rarely) occur in swamp forest areas, as observed by Corner (1939). They can grow into trees of impressive size (to over 30 m tall: *Ridley 11332*). In contrast, *G. tubifera* var. *tubifera* forma *tubifera* is a typically coastal estuarine and swamp forest species, and a much smaller tree (up to about 13 m tall).

The two forms of *G. tubifera* var. *tubifera* recognised by Wong (1982, 1989) were distinguished also based on the hairiness of veins on the lower leaf surface, leaf width, calyx tube length, corolla tube length, fruit size and habitat. Table 1 shows that, whereas leaf width, calyx tube length and corolla tube length are not consistent in their differences, further differences in flower and fruit pedicel thickness, calyx mouth width and fruit size (verified through the present study) indeed help in distinguishing these two rather distinct taxa.

G. tubifera var. *tubifera* forma *elata* (previously *G. elata*) has a puberulent midrib and secondary veins on the lower leaf surface, thicker (2-3 mm) flower pedicels, a much wider calyx mouth [8-13(-15) mm], thicker fruit pedicels [(2-)4-10 mm], and larger fruits [(3-)4-6.5 cm]. In contrast, *G. tubifera* var. *tubifera* forma *tubifera* was distinguished by having a glabrous midrib and secondary veins on the lower leaf surface, more slender flower pedicels (1-2 mm), a narrower calyx mouth (5-8 mm), more slender fruit pedicels (1.5-4 mm), and smaller fruits (2.4-3 cm).

In summary, these two taxa are differentiated by a suite of consistent characters (Table 1), including various features of the reproductive parts,

Table 1. A comparison of habitat and morphological characters among *G. subcarinata, G. elata* and *G. tubifera.*

	G. subcarinata	*G. elata*	*G. tubifera*
Provenance	Malay Peninsula & Sumatra	Nicobar Islands, Thailand, Malay Peninsula, Sumatra, Borneo, Sumbawa & Philippines	Thailand, Malay Peninsula, Sumatra & Borneo (Kalimantan only)
Ecology	lowland forest	lowland forest	coastal estuarine & swamp forest
Leaf blade, length (cm)	(4.5-)7-14	(4.3-)10-22.5(-27)	4.5-12.5(-21)
Leaf blade, width (cm)	(1.9-)2.2-4.6	(2-)4-11(-12)	2.3-5.6(-6.3)
Leaf blade, pairs of secondary veins	7-12	(7-)14-22	9-15(-17)
Lower leaf surface, pubescence on midrib & secondary veins	puberulent	puberulent	generally glabrous (very rarely sparsely minute puberulent)
Flower pedicel, length (cm)	0.1-0.5	0.1-0.4(-1)	0.2-0.5
Flower pedicel, thickness (mm)	1.2-1.8	2-3	1-2
Calyx tube, length (cm)	0.4-0.7	(0.6-)1.4-2.5(-3.5)	0.6-1.5(-1.9)
Calyx tube, width at mouth (mm)	4-8	8-13(-15)	5-8
Calyx tube, pubescence	puberulent	puberulent	sparsely puberulent to subglabrous
Calyx tube, keels presence	8-9 narrow keels present along the tube	keels absent	keels absent
Corolla tube, length (cm)	4.6-6.8	(4.5-)7-15	(2.4-)3.9-9.4
Corolla tube, width at middle (mm)	1.5-3	2.5-5	1.5-3
Corolla lobes, length (mm) 12-21	12-21	(16-)32-45(-50)	14-29
Corolla lobes, width (mm)	6-13	10-20(-24)	7-18
ameter at or near maturity (cm)	1.5-2.5(-2.7)	(3-)4-6.5	2.4-3
Fruit pedicel, length (cm)	0.1-0.4	0.2-1(-1.5) or more	0.2-1.5
Fruit pedicel, thickness (mm)	2.5-3	(2-)4-10	1.5-4

instead of just smaller differences that would be expected among forms of the same species or variety. The different ecological distributions of these taxa also support a more fundamental distinction. We propose that their original distinction as species, *G. elata* Ridl. and *G. tubifera* Wall., should be restored.

Two new varieties in the *Gardenia tubifera* complex

Based on similar considerations, we propose a new variety of *G. elata* from Luzon material, and also a new variety of *G. subcarinata* from Sumatra. These two new taxa differ from their respective typical varieties in only minor details and distribution, rather than by the larger suites of characters that consistently separate taxa at the species level (see key below).

The new variety of *G. elata* has longer flower pedicels (0.7-1 cm) compared to the typical *G. elata* (only 0.1-0.5 cm long). On the other hand, although the new variety of *G. subcarinata* has the keeled calyx tube form of typical *G. subcarinata*, it differs in that the keels do not protrude beyond the calyx tube margin (in typical *G. subcarinata*, the calyx keels protrude, as distinct lobes, about 2 mm beyond the calyx tube margin). Otherwise, these two taxa are indistinguishable from their typical forms.

Key to taxa in the *Gardenia tubifera* complex

1. Calyx outer surface keeled ……..…….. 2
1. Calyx outer surface smooth or at most very faintly ribbed upon drying (the ribs resembling longitudinal veins, not laminate keel structures) …...…….3

2. Calyx keels ending in distinct spur-like expansions protruding up to 2 mm beyond the calyx tube margin (Malay Peninsula and Singapore) ....…. ***G. subcarinata* var. *subcarinata***
2. Calyx keels not forming expanded apical portions and not protruding beyond the calyx tube margin (Sumatra) ……..... .....…..… ***G. subcarinata* var. *sumatrana***

3. Veins on the lower leaf surface glabrous (very rarely sparsely minute puberulent); calyx mouth of open flowers *ca* 5-8 mm wide; mature fruit *ca* 2.4-3 cm across (coastal estuarine to swamp forests only) ….. ***G. tubifera***
3. Veins on the lower leaf surface puberulent; calyx mouth of open flowers *ca* 8-13(-15) mm wide; mature fruit *ca* (3-)4-6.5 cm across (typically lowland to hill forests, very rarely swamp forest) ……...……. 4

4. Pedicels of open flowers *ca* 0.1-0.4(-0.5) cm long (Borneo, Malay Peninsula, Nicobar Islands, Philippines, Singapore, Sumatra, Sumbawa, Thailand) .... ***G. elata* var. *elata***
4. Pedicels of open flowers *ca* 0.7-1 cm long (Philippines: known only in Luzon from the Cagayan, Isabela and Rizal provinces) .... ***G. elata* var. *longipedicellata***

Taxonomic enumeration

1. *Gardenia elata* Ridl. var. ***elata***
J. Straits Branch Roy. Asiat. Soc. 79 (1918) 81. – **Type:** Singapore, Bukit Timah, 1898, *Ridley 11332* (lecto, K, hic designatus; isolecto, SING). **Fig. 1.**
-*Gardenia tubifera* var. *tubifera* forma *elata* (Ridl.) K.M.Wong, Gard. Bull. Singapore 35 (1982) 22, Tree Fl. Malaya 4 (1989) 349; Coode et al., Checkl. Fl. Pl. Gymnosperms Brunei Darussalam 270 (1996), *quoad Ashton BRUN 1008*, *Ashton S 7834*, *Niga 52*, *Niga 63*, *Sands 5869*, *Simpson 2007*, *Wong WKM 571*.
-*Randia speciosa* Hook., Icon. Pl. 5 (1852) t. 824, *nom. illeg., haud Randia speciosa* DC., Prodr. 4 (1830) 388; *Gardenia speciosa* Hook.f., Fl. Brit. Ind. 3 (1880) 117, King & Gamble, J. Asiat. Soc. Beng. 72 (2) (1903) 220, Ridley, Fl. Malay Penin. 2 (1923) 83, *nom. illeg., haud Gardenia speciosa* Salisb., Prodr. Stirp. Chap. Allerton (1796) 63, *nec Gardenia speciosa* Roxb. ex Wight & Arn., Prodr. Fl. Ind. Orient. (1834) 422. -Type: Hook., Icon. Pl. 5 (1852) t. 824 (*Randia speciosa* Hook.).
-*Gardenia lobbii* Craib, Fl. Siam. 2 (1932) 120. (Craib proposed this as nom. nov. for *G. speciosa* Hook.f.). See above.
-*Gardenia longiflora* S.Vidal, Revis. Pl. Vasc. Filip. (1886) 153, *nom. illeg.*; Merrill, Enum. Philipp. Fl. Pl. (1923) 530; *haud Gardenia longiflora* Ruiz & Pav., Fl. Peruv. 2 (1799) 67, t. 219, *nec Gardenia longiflora* (Salisb.) Dryander in Aiton, Hortus Kew., ed. 2, 1 (1810) 368. -Type: Luzon, Camarines Province, Paracale, Jan 1884, *Vidal 832* (open flower & fruit) (isotype, K).
-*Gardenia longituba* Ridl., J. Bot. 72 (1934) 274. -Type: British North Borneo, Kudat, Jul 1885, *Fraser 164* (flower bud) (holotype, K).
-"*Gardenia glutinosa*" *auct. non* Teijsm. & Binn. (1866): Elmer, Leafl. Philipp. Bot. 4 (1912) 1331: *quoad Elmer 13064*.
-"*Gardenia tubifera*" *auct. non* Wall. ex Roxb. (1824): Corner, Gard. Bull. Straits Settlem. 10 (1939) 46, *pro parte: quoad G. speciosa* Hook.f. & *G. elata* Ridl. in syn.; Corner, Wayside Trees of Malaya 1 (1952) 541; Anderson, Checkl. Trees Sarawak 297 (1980); Kessler et al., Secondary Forest Trees of Kalimantan, Indonesia (2000) 135, *quoad* Fig. 134.

Tree to *ca* 30 m high, trunk to *ca* 119 cm diameter, not buttressed. **Bark**

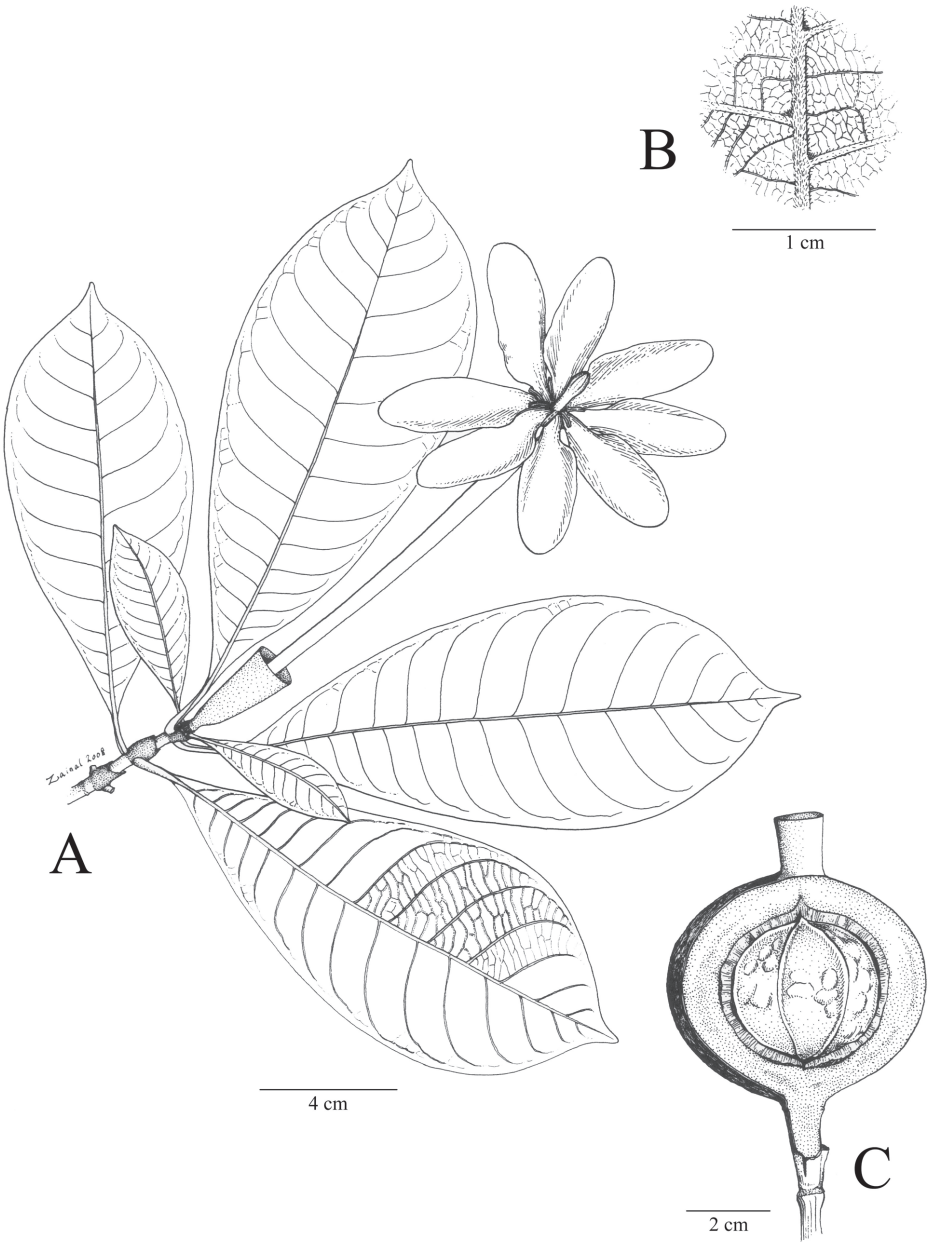

Figure 1. *Gardenia elata var. elata*. A, Flowering leafy branch. B; Detail of puberulent veins on lower leaf surface; C, Longitudinal section of fruit, calyx shown intact. [A & B from *Symington 24190* (SING); C from *Sigin & Ismail SAN 100264* (L)].

smooth, light grey-brown to dark brown. **Stipules** connate into a cylindrical tube, (0.4-)0.6-1.5 cm long, apex 2-lobed to subtruncate, outside puberulent and generally coated with resin (this sloughing off in older material), inside with a mixture of dark-coloured colleters and scattered fine translucent trichomes densely covering the basal half (trichomes slightly longer than the colleters) and glabrous in the upper half. Petiole (0.3-)1.1-3.5(-3.8) cm long, 1-2(-2.5) mm thick, evenly covered with puberulent hairs, sometimes conspicuously resin-coated. **Leaf** lamina obovate to rarely elliptic, (4.3-)10-22.5(-27) cm long, (2-)4-11(-12) cm wide; leaf base cuneate to rarely oblique; leaf apex cuspidate; thinly coriaceous; conspicuously coated with resin when young; midrib flat to sunken and minutely puberulent to subglabrous on upper side, prominent and puberulent on lower side; secondary veins (7-)14-22 pairs, flat and subglabrous on upper side, prominent and puberulent on lower side, vein axils on the lower side with ciliate tuft-domatia to hairy pocket domatia; tertiary venation scalariform. **Flowers** solitary. Pedicel 0.1-0.4(-1) cm long and 2-3 mm thick in open flowers, reaching 0.2-1(-1.5) cm long and (2-)4-10 mm thick at fruit maturity. **Calyx** narrowly obconical to somewhat spindle-shaped, the apex often slightly oblique and torn into two acute portions with corolla emergence, the tube subsequently slightly flared outward and often appearing subtruncate in the open flower; medium green; (0.6-)1.4-2.5(-3.5) cm long, 4-6 mm wide at the base, becoming 8-13(-15) mm wide at the apex; outside densely puberulent at the base and sparsely puberulent to subglabrous in the upper part, often coated with resin; inside glabrous for most of the upper part to about 0.7 cm from the tube margin, densely covered with a mixture of dark-coloured colleters and translucent trichomes at the basal half (trichomes longer than colleters and especially conspicuous as a dense fringe at the very base of the calyx); without lobes; surface smooth, without keels or ribs. Corolla hypocrateriform, cream turning light yellow, then deep to orange yellow; tube (4.5-)7-15 cm long, 2.5-5 mm wide at the mid-portion, 6-13 mm wide at the throat, outside glabrous to sparsely puberulent, inside largely glabrous except for a zone of dense ribbon-like translucent hairs from the throat to around the middle of the tube; lobes 8-10, oblanceolate to obovate, (16-)32-45(-50) mm long, 10-20(-24) mm wide, contorted to the left in the bud stage, glabrous on both sides. Stamens 8-10, inserted just below the corolla throat and between corolla lobes, dorsifixed; filaments very short to inconspicuous; anthers 7-10 mm long, *ca* a third to half of its length exserted; pollen in tetrads. Style (4.5-)9-15.5 cm long, glabrous; stigma club-like with 5-8 lobes initially cohering together, (4-)6-8 mm long, 3-5 mm wide, wholly exserted; ovary with several parietal placentas. **Fruits** globose, rarely depressed globose or obovoid, (3-)4-6.5 cm long, (3-)4-7 cm wide, surface in mature specimens smooth; calyx persistent at fruit apex, the tube to 1-2.5 cm long, 0.8-1.5 cm wide at

the mouth; when ripe splitting irregularly to expose dark coloured seeds embedded in a bright yellow-orange pulp. **Seeds** many, irregularly angular-elliptic, flattened, 5-6 mm long, 4-7 mm wide, testa surface fine-areolate.

Habitat and ecology: Lowland forests preferring drier sites (including ultramafic and volcanic soils in north Borneo and the Philippines), very rarely in freshwater swamp forest.

Distribution: Widespread from the Nicobars, Thailand, Malay Peninsula, Bangka, Sumatra, Sumbawa, Borneo to the Philippines (including Palawan) (Fig. 2).

Proposed IUCN conservation assessment: *Gardenia elata* is a widespread species although not commonly encountered, so that the status Least Concern (LC) is still appropriate. However, with forest conversion rates increasing steadily in the region, this status needs reassessment periodically.

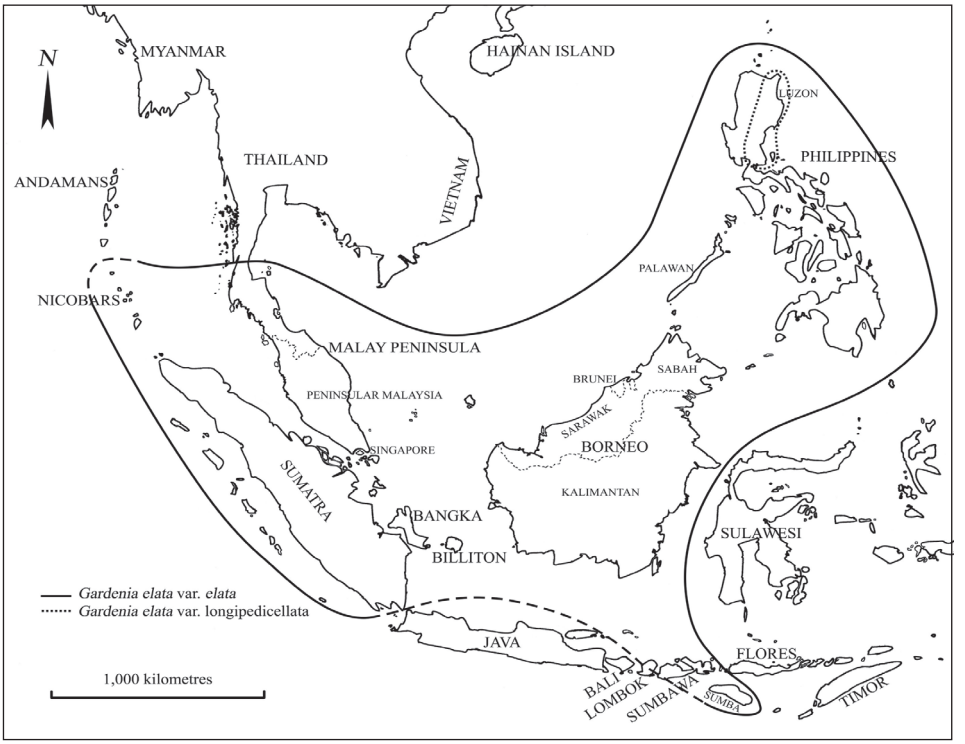

Figure 2. Range of *Gardenia elata* var. *elata* (indicated by solid line, with uncertain parts represented by dashed lines) and the area of occurrence of *G. elata* var. *longipedicellata* on Luzon island, the Philippines (within dotted line).

Notes: When Ridley first published *G. elata*, he cited only three specimens, namely, *Ridley 11332* (Bukit Timah, Singapore), *Wray 4266* (Selama, Perak) and *Hose 229* (Baram, Borneo). As there was no particular type indicated, all three specimens cited are syntypes. Corner (1939) considered *G. elata* a synonym of *G. tubifera* Wall. In recognising *G. elata* as a form of *G. tubifera* var. *tubifera*, Wong (1982) recorded *Wray 4265* (Selama, Perak, SING) as one of the syntypes, instead of *Wray 4266* as stated by Ridley (1918). King and Gamble (1903) had also listed *Wray 4265* under *G. speciosa* Hook.f., also a synonym of *G. elata*. It has now been confirmed that *Wray 4266* (SING) is a species of *Brachylophon* (Malpighiaceae) (Serena Lee, *pers. comm.*). As lectotypification is required for this species under Article 9.9 of the International Code of Botanical Nomenclature (McNeill *et al.*, 2006), we have avoided choosing the Wray specimen but instead select *Ridley 11332* (K) as the lectotype.

Gardenia longituba Ridl., overlooked by Corner (1939), was considered closely related to *G. longiflora* S.Vidal by Ridley; in fact, both these names are synonyms of *G. elata*. Ridley's description of *G. longituba* as having an unusually hairy stigmatic head was erroneous; close examination of the type material, *Fraser 164* (Kudat, British North Borneo, K), shows that the otherwise smooth stigmatic head was in fact occluded by external fibres, possibly from paper or cardboard material used when preparing herbarium specimens. This taxon perfectly matches *G. elata.*

Specimens examined: BRUNEI: **Belait District.** Andulau Forest Reserve, compartment 5, 10 Jun 2008, *Low et al. LYW 180*, fruits (BRUN, KLU); Belait river, upstream from the Malayan river, 23 Oct 1988, *Wong WKM 571*, flower (A, BRUN, KEP), flowers (L, SAN); Bukit Sawat, Sungai Mau, along Sungai Belait, 15 Oct 1991, *Simpson 2007*, fruit (A, BRUN, KEP, L, SAN, SING); Sukang, Kampong Sukang, 21 Jul 1993, *Sands et al. 5869*, fruit (A, BRUN, SAN, SING); Sungai Mau, 18 Aug 1988, *Nangkat NN 52*, fruit (A, BRUN, SAN, SING); ibid., 28 Jan 1989, *Nangkat NN 63*, flower (KEP, L, SAN, SING), flowers (A, BRUN), fruit (SING); **Muara District.** Berakas Forest Reserve, 31 Sept 1959, *Ashton BRUN 1008*, fruit (BRUN, SING); ibid., 12 May 1957, *Ashton S 7834*, flower (A, BO, BRUN, KEP, SAR). INDIA: **Nicobar Islands.** North Nicobars, Katchall Island, 17 May 1975, *Chakrakanly 2557*, flower (L). INDONESIA: **Java.** Cult. Hort. Bogor V.10.49, 1903, Anon. s.n., flower (A); Tjibodas, sine date, Anon. s.n., flowers (IBSC). **Kalimantan. East Borneo.** Berau, Inhutani area, Km 37 near transect I, plot 6, 7 Oct 1997, *Ambriansyah et al. Berau 841*, fruit (A), fruits (L); Commisi Kap. Genderen Stort., Gunung Samenggaris, Dec 1912, *Amdjah 1094*, flower (K, SING), flowers (A, BO 2 sheets), fruit (BO); Lojanan to Tenggarong road, Kampung Rempaya, 26 Oct 1995, *Ambri et al. AA 1416*,

flower (A, K, KEP, L, SAN); Sei. Seluang, 20 km from Wanariset, Waduk road, 11 Jul 1995, *Ambri et al. AA 1291*, fruit (A, BO, SAN), fruits (L); **South Borneo.** Sungai Wain region, North of Balikpapan, Oct 1950, *Kostermans 4323*, immature fruit (A); **West Borneo.** Pontianak, Bentiang, Gunung Sekaju, West of Kampung Madamang, 6 Nov 1980, *Shea 27578*, fruit (A); West Koetai, 21 Aug 1929, *Endert 2765*, fruit (A, BO). **Sumatra,** Bangka, Lombok Besar, 1 Sep 1949, *Kostermans & Anta 282*, fruit (A, KEP), fruits (L, NY, SING); East Coast, Asahan, Kuala Masihi, Apr 1927, *Yates 2397*, flower (L, US), flowers (A, NY, SING); North Siberut Island, Gunung Simapipit, 26 May 1994, *Afriastini 2737*, fruit (K), fruits (L); Palembang, 16 Dec 1916, *Lambach 1354*, flowers (BO); Riau, Tigapuluh Mountains, 15 km Southwest of Talanglakat, Rengat-Jambi road, vicinity of Sungai Serisih, 24 Nov 1988, *Burley et al. 1680*, fruit (KEP, L, NY, SING), fruits (A); South Sumatra, Barisan Range, Seleman Enim, Bukit Seburong near Muara Dua, 15 Mar 1972, *de Vogel 1299*, fruits (L); Southeast Sumatra, Lampung, Way Kambas, 3 Feb 1972, *Mochtan 24A*, fruits (L); West of North Sumatra, Simaloer Island, 1 Nov 1918, *Achmad 709*, fruit (L). **Sumbawa,** Central Sumbawa, Dompu, Raba Baka Trail to Matuatoi, 6 Jun 1961, *Soejarto 60*, fruits (BO); West Sumbawa, Semongkat Atas, 17 km South of Sumbawa Besar, 2 May 1961, *Kuswata 112*, fruit (BO, SING), fruits (A, BO). MALAYSIA: **Peninsular Malaysia. Johor,** Kota Tinggi, Sungei Bang, 13 Mar 1966, *Sinclair 10863*, flowers (US 2 sheets); Mawai to Jemilang Road, Sungai Berassau, 6 Feb 1935, *Corner 28736*, fruits (SING), Sungai Kayu near Sungai Sedili, 10 Mar 1937, *Kiah SFN 32368*, fruits (A, SING), Sungai Sedili, 28 Mar 1937, *Corner 32440*, flower (BO), flowers (A, SING 3 sheets). **Kedah,** Koh Mai Forest Reserve, 3 Apr 1938, *Kiah SFN 35148*, flowers (A, SING 2 sheets); Ulu Muda Forest Reserve, 21 Jan 1969, *Chan FRI 6777*, fruit (A). **Kelantan,** Kuala Krai, Taman Negara, Kuala Koh Headquarters, 30 Mar 1995, *Latiff et al. 4168*, flower (K, L); Ulu Lebir Forest Reserve, 12 Aug 1970, *Suppiah FRI 11681*, fruit (L 2 sheets). **Melaka,** Chaban, 28 Sep 1885, *Alvin 2364*, fruits (SING); Kemandore, 14 Jul 1917, *Burkill 2509*, fruits (SING). **Negeri Sembilan,** Pasoh Forest Reserve, 6 Jul 1988, *LaFrankie 3032*, fruits (A); ibid., 16 Jul 2008, *Wong & Zulkapli* s.n., leafy branch (KLU). **Pahang,** Rompin, Pulau Tioman, Sungai Asah to waterfall, 29 Apr 1995, *Zainudin & Bedul 5477*, flowers (L), Ulu Sungai Sat, 11 Jul 1970, *Mohd Shah & Mohd Noor MS 1833*, fruit (A, L, US), fruits (SING). **Perak,** Gopeng, Apr 1884, *King's collector 5830*, flower (L); Gunong Bubu via Trong, 27 Apr 1970, *Suppiah FRI 11673*, fruit (K, L), near Selangore, Apr 1886, *King's collector 8736*, flowers (K); Selama, 1894, *Wray 4265*, flowers (SING). **Selangor,** Gombak, 27 Jun 1960, *Poore 185*, fruit (KLU); Kajang, Bukit Enggang, 9 Apr 1930, *Symington 24190*, flower (SING); Sungai Buloh, 1891, *Ridley* s.n., fruits (SING); Sungai Buloh Reserve, 25 Mar 1919, *Abu 3313*, flowers (SING).

Terengganu, Kuala Trengganu, Jerteh, Gunung Tebu Forest Reserve, compartment 65, 12 Oct 1971, *Zainuddin FRI 17945*, fruit (A, L, SING), Kuala Trengganu, logging school area, 14 Nov 1978, *Suppiah FRI 28251*, fruit (A). **Sabah. Beaufort,** Membakut, Kampung Binsulok Forest Reserve, 23 Apr 1984, *Ag. Amin & Haya SAN 102465*, flower (A, KEP, L, SAN, SING), flowers (SAN); **Beluran,** Tongod, Ulu Sungai Pinangah, 16 Oct 1984, *Amin et al. SAN 107143*, fruit (SAN 2 sheets); **Kalabakan,** Benaword logged over area, 11 Apr 1980, *Fedilis & Sumbing SAN 91785*, fruit (SAN); Maliau Basin, Rafflesia Camp to Resak Island, 26 Apr 2000, *Ming et al. MB 283*, fruit (KEP, SAN); **Keningau,** Shang Lian logging area, LANAS, 16 Oct 1986, *Mantor SAN 118392*, fruit (SAN) fruits (SAN); **Kinabatangan,** Gunung Rara Forest Reserve, Maliau river, 11 Apr 1996, *Puff 960411-1/2*, flowers (SAN); Lamag, Gunong Lotung, 5 miles Southeast of Inarat, 7 May 1976, *Cockburn SAN 83039*, flower (A, KEP, SAN, SING); Lamag, Sogo-sogo, Kampung Tongod, 22 Nov 1979, *Madani SAN 91125*, flower (K, KEP, SING), flowers (SAN); Lamag, Tanegang Kechil, 26 May 1965, *J. Singh & Eging SAN 51864*, flowers (K, SAN, SING); Sukau, Sungai Menanggul, 13 May 1996, *Azmi et al. RA 512*, flower (L), flowers (KEP), flower & flower bud (K, SAN); **Kuala Penyu,** Kepayan, 20 Aug 1993, *Ag. Amin SAN 127290*, fruit (K), fruits (SAN); Mempakul, Malikai, 25 Feb 1937, *Mail 7060*, flower (A, SING); **Kudat,** without locality, 7 Aug 1885, *Fraser 164*, flowers (K); Berambangan, 9 Jul 1962, *Brand SAN 30870*, fruit (SAN); Dumpirit, *Balajadia,* 7 Feb 1933, *NBFD 2843*, flower (BO), flowers (A); **Lahad Datu,** Mile 17.7 of Kalumpang-Tawau road, 16 Sep 1962, *Chai SAN 29828*, fruit (BO, KEP, SAN, SING); Pulau Sakar, 16 Mar 1961, *H.S.M. & D. Brand SAN 24552*, flower (SING), flowers (SAN), flowers & fruit (BO, KEP,); **Nabawan,** Sepulut, Sepulut Forest Reserve, Labang, 17 Oct 1988, *Fedilis & Sumbing SAN 125652*, fruit (SAN); Sungai Tibow, 18 Jul 1984, *Fedilis & Sumbing SAN 105342*, fruit (SAN); **Papar,** Mandahan Forest Reserve, 8 Jul 1987, *Ag. Amin SAN 103348*, immature fruit (SAN), fruits (K); **Ranau,** without locality, 23 Feb 1990, *Majawat SAN 125800*, fruit (KEP, L); Bongkud, 26 Mar 1986, *Amin et al. SAN 105640*, flower (A, K, KEP, SAN, SING); **Sandakan,** Kretam, Sungai Kulamba, 9 Apr 1984, *Sundaling SAN 55998*, flower (A, L, SAN 2 sheets); Labuk Road Forest Reserve, 11 Feb 1993, *Wong WKM 2600*, flowers (SAN); Sepilok Forest Reserve, Jalan Hg. Tanjong Cpt. 13, 24 Sep 1968, *Patrick SAN 63508*, fruit (L), fruits (SAN); Sungai Dagat, 14 Jul 1987, *George et al. SAN 120736*, fruit (K, KEP), fruits (SAN); Sungai Malikop, 25 Aug 1984, *Sigin & Ismail SAN 100264*, fruit (L, SAN); Telupid, Kampung Wonod, 19 Mar 1974, *Aban & Saikeh SAN 79413*, flower (A, K, SING) flowers (A, KEP, SAN); **Semporna,** Bodgaya, 6 May 1939, *Valera SHN 10263*, flower (SING), flowers (KEP); Semporna, Mile 25 of Pagagau Road, 11 Mar 1965, *J. Singh et al. SAN 48883*, flower (NY), flowers (SAN); **Sipitang,** Melaliah, 19 Oct 1961,

Md. Thaufeck SAN 27148 No. 19, fruit (BO, SING), fruits (SAN); **Tawau,** Bombay Burmah Timber Company Concession, Sub-compartment no. 2 of Compartment no. 1, 28 Nov 1954, *Wood SAN A3973*, fruit (KEP), flowers & fruits (L); Elphinstone Province, Oct 1922-Mar 1923, *Elmer 20544*, fruit (A 2 sheets, IBSC, L, NY, SING); Mostyn, Tengkayu Waterfall, Sabah Timbers Company, 28 May 1965, *Madani SAN 47171*, flower (K), flowers (SAN); Kalabakan Road, Mile 12, 26 Jul 1962, *Aban SAN 30557*, fruit (L, SAN), fruits (KEP); **Tenom,** Mandalom Forest Reserve, 17 Sep 1986, *Mantor SAN 116647*, fruit (SAN 2 sheets). **Sarawak.** without locality, 1865-1868, *Beccari 3250*, flower (K), sine date, *Native Coll. 214*, flowers (US); **1st Division,** Kuching, Matang, Aug 1912, *Anderson 6*, flowers (SING); Kuching, Matang Road, 10 Jul 1964, *Salleh 12092*, flower (A, K, NY); Mount Matang, 27 Oct 1929, *J. & M.S. Clemens 22334*, flower (K, SAR), flowers (A, K, NY); Kuching, Santubong, 19 Nov 1904, *Egon 252*, fruit & flower (SAR); Simunjan, Serian to Simanggang Road, Ulu Simpang Sabal Aping, Gunong Gaharu, 9 Oct 1974, *Ilias & Azahari S 35687*, fruit (KEP, L, SAN, SAR); 26th Mile Bau/ Lundu Road, Sampadi Forest Reserve, 17 Jun 1968, *Jugah S 24948*, flower (SAN) flowers (A, K, SAR); **2nd Division,** Sri Aman, 95th Mile, Kampong Pungor Tapang, 9 Mar 1981, *Ilias S 42712*, fruit (KEP, L, SAN); **3rd Division,** Kapit, Balleh, Ulu Sungai Mengiong, Apan Entelit, 14 Mar 1996, *Rantai et al. S 74211*, fruit (K, KEP, SAN, SAR, SING); **4th Division,** Bintulu, Nyabau Catchment Area, 22 Jun 1966, *Sibat S 24617*, flower (A, BO, KEP, SAN, SING), flowers (K, SAR); **5th Division,** Baram district, Miri river, Feb 1895, *Hose 506*, flowers (K, L). PHILIPPINES: **Busuanga.** without locality, Sep 1922, *Ramos Bur. Sci. 41218*, immature fruit (K, L); NE of Coron, 2 km north of San Nicolas, along Wayan Creek, 29 Jun 1984, *Bourell 2439*, fruit (A). **Culion,** without locality, 29 Apr 1931, *Herre 1085*, flowers (A), flower & flower buds (NY); Apr 1931, *Herre 1088*, fruit (NY). **Luzon,** Camarines Province, Paracale, Jan 1884, *Vidal 832*, flower & fruit (K); Laguna Province, Dahican River, Sep 1912, *Ramos 1325*, fruit (A, L, NY, SING); Tayabas Province, May-Jun 1916, *Cailipan For. Bur. 25640*, fruit (K, US); Lucban, May 1907, *Elmer 7732*, fruit (A). **Mindanao,** Zamboanga, Feb 1908, *Whitford & Hutchinson For. Bur. 9492*, flower (NY, US). **Palawan,** without locality, May 1913, *Merrill 1360*, flower bud & fruit (A, NY, SING); Bataraza, Bgy. Sumbiling, Sitio Gamayon, Bulanjao Range, 8°33'N 117°24'E, 21 Mar 1995, *Soejarto & Madulid 9030*, fruit (A, PNH); Puerto Princesa, Irawan, Impapai hills above BFD Field Station, 9°51'N 118°37'E, 26 Jun 1992, *Soejarto & Fernando 7750*, flower & flower buds (K, NY); Irawan, Irawan River Valley, Tatanarom, road to Benguet mine, Mt Beaufort, 9°50'N 118°40'E, 16 Jul 1988, *Soejarto & Madulid 6066*, fruit (NY, SING, US); Irawan R. valley head, 19 Mar 1984, *Ridsdale SMHI 145*, flower bud (A, BO, K, KEP, L); lower slopes of Mt Beaufort, 30 Mar 1984, *Ridsdale SMHI 291*, flowers & flower

bud (A, BO, K, L, SAN); Puerto Princesa, Mt Pulgar, Apr 1911, *Elmer 13064*, flower (NY, US), flower & immature fruit (A); Pulot, Massin River, 12 km N. Brooks Point, 23 Oct 1985, *Ridsdale 998*, fruit (A, L 2 sheets); Taytay, May 1913, *Merrill 1279*, flower (A, NY, SING); Taytay, island on Lake Manguao, *ca* 10 km SE of Taytay town, 10°50'N 119°33'E, 30 Jan 1991, *Soejarto & Fernando 7419*, fruit (A, PNH); valley stream leading into NNW bay of lake, 7 Apr 1984, *Ridsdale SMHI 357*, fruit (A, BO, KEP, L, SAN). **Panay,** Capiz Province, Oct-Nov 1925, *Edano Bur. Sci. 46123*, fruits (A, BO, NY, SING). **Sibuyan,** Capiz Province, Magallanes, Mt Giting-Giting, Mar 1910, *Elmer 12103*, flower & flower buds (A) flower (NY, US). **Tawi-tawi,** Sulu Province, Jul-Aug 1924, *Ramos & Edano Bur. Sci. 44127*, fruit (A, NY, SING, US). SINGAPORE: Bukit Timah, 1898, *Ridley 11332*, flower (K, SING), Bukit Timah Reserve, tree no. 166, 21 Jul 1938, *Ngadiman SFN 35595*, fruit (A); Gutta Valley, 1907, *Ridley* s.n., fruit (SING). THAILAND: **Peninsular Thailand,** Narathiwat, Waeng, Klong A-re-ma, 3 May 1999, *Puudja 561*, flower (BKF); Pattani, Banang, 22 Jul 1923, *Anon. 7275*, fruit (K); Sukinin District, Tomo Mine, 25 Dec 1999, *Wongprasert 9912-38*, fruit (BKF); Trang, Talay Songkong, 19 Mar 1915, *Vanpruk 661*, flower (BKF), flowers (K).

1a. ***Gardenia elata*** var. ***longipedicellata*** K.M.Wong, ***var. nov.***
A var. typica pedicellis floris longioribus (7-10 mm longis) differt. **-Typus:** Luzon, Cagayan Province, May 1921, *Ponce For. Bur. 28435* [holo, A (sheet 1 of 2); isotypi, A (sheet 2 of 2), US]. **Fig. 3.**

Habitat and ecology: Lowland forests (including on ultramafic soils).

Distribution: Endemic to the Philippines, Luzon (Cagayan, Isabela and Rizal provinces) (Fig. 2).

Proposed IUCN conservation assessment: Vulnerable due to very few known, small or restricted populations (VU D2).

Note: This is recorded as a tree reaching about 15 m high. It shares much similarity with the typical variety, differing only by its longer (0.7-1 cm) flower pedicels compared to those of *G. elata* var. *elata* (only 0.1-0.4(-0.5) cm long).

Specimens examined: PHILIPPINES: **Luzon,** Cagayan Province, May 1921, *Ponce For. Bur. 28435*, open flower (A, 2 sheets; US); ibid., Jan-May 1915, *Velasco For. Bur. 24116*, open flower & fruit (US); Isabela Province, Mar 1910, *Bernardo For. Bur. 15478*, flower (L), Kapuntian, San Jose, San Mariano, 16°59.7'N 122°2.3'E, sine date, *Barbon et al. PPI 13137*, immature

Figure 3. Close-up of flower of *Gardenia elata* var. *longipedicellata* from Bernardo For. Bur. 15478 (L).

fruit (L); Isabela Province, Palanan, Digallorin, Divinisa camp site, 16˚30'N 122˚26'E, 10 Apr 1992, *Ridsdale et al. ISU 479*, flower bud (A, BO, K, L); Rizal Province, Feb 1905, *Ahern's Collector For. Bur. 2673*, fruit (NY, SING, US); ibid., May 1907, *Ramos Bur. Sci. 2689*, open flowers (US).

2. ***Gardenia subcarinata*** (Corner) Y.W.Low, *comb. et stat. nov.*
Basionym: *Gardenia tubifera* var. *subcarinata* Corner, Gard. Bull. Straits Settlem. 10 (1939) 48; Gard. Bull. Singapore 35 (1982) 22; Tree Fl. Malaya 4 (1989) 349. – **Type:** Penang, Government Hill, Feb 1889, *Curtis 686* (holo, SING 0048397; iso, SING 0048383). **Fig. 4A-C.**
-"*Gardenia resinifera*" *auct. non* Roth, Nov. Pl. Sp. (1821): Ridley, Fl. Malay Penin. 2 (1923) 83.
-"*Gardenia tubifera*" *auct. non* Wall. ex Roxb. (1824): King & Gamble, J. Asiat. Soc. Beng. 72 (2) (1903) 219 (as "Form 2").

Tree, to *ca* 15 m high, trunk to *ca* 76 cm diameter, not buttressed. **Bark** smooth, light grey-brown to dark brown. **Stipules** connate into a cylindrical tube, 0.2-0.4 cm long, apex 2-lobed to subtruncate, outside puberulent and

generally coated with resin (this sloughing off in older material), inside with a mixture of dark-coloured colleters and scattered fine translucent trichomes densely covering about three quarters of the surface from the base (trichomes slightly longer than the colleters) and glabrous in the upper part. Petiole (0.5-)0.6-1.5 cm long, 1-2 mm thick, evenly covered with puberulent hairs, sometimes conspicuously resin-coated. **Leaf** lamina obovate (4.5-)7-14 cm long, (1.9-)2.2-4.6 cm wide, leaf base cuneate, apex cuspidate, thin-coriaceous, conspicuously coated with resin when young; midrib slightly raised to flat and puberulent on upper side, prominent and puberulent on lower side; secondary veins 7-12 pairs, flat to sunken and glabrous on upper side, prominent and puberulent on lower side, vein axils on the lower side with hairy pocket domatia; tertiary venation scalariform. **Flowers** solitary. Pedicel 0.1-0.3 cm long and 1.2-1.8 mm thick in open flowers, reaching 0.1-0.4 cm long and 2.5-3 mm thick at fruit maturity. **Calyx** obconical, slightly flared outwards at the apex; medium green; 0.4-0.7 cm long, 2-3.5 mm wide at the base, becoming 4-8 mm wide at the apex; outside densely puberulent, often coated with resin; inside glabrous for most of the upper half, densely covered with a mixture of dark-coloured colleters and translucent trichomes at the basal half (trichomes longer than colleters and especially conspicuous as a dense fringe at the very base of the calyx); marginal lobes 7-9, subtriangular to rounded, about 0.5-1 mm high; keels present, generally alternating with the calyx lobes, forming narrow spurs at the apex that protrude up to 2 mm beyond the calyx tube margin, narrowing gradually towards the base of the calyx limb but not extending downward to the hypanthium. Corolla hypocrateriform, cream turning light yellow, then deep to orange yellow; tube to 4.6-6.8 cm long, 1.5-3 mm wide at the mid-portion, 7-8 mm wide at the throat, outside glabrous to puberulent, inside largely glabrous except for sparse ribbon-like translucent hairs in narrow zones between stamens from the throat to just below the anthers; lobes 6-9, oblanceolate to obovate, 12-21 mm long, 6-13 mm wide, contorted to the left in the bud stage, glabrous on both sides. Stamens 6-9, inserted just below the corolla throat and between corolla lobes, dorsifixed; filaments very short to inconspicuous; anthers 5-7 mm long, c. a third to half of its length exserted; pollen in tetrads. Style 7.5-8 cm long, glabrous; stigma club-like with 3-4 lobes initially cohered together, 2-5 mm long, 1.5-3 mm wide, wholly exserted; ovary with several parietal placentas. **Fruits** subglobose, 1.5-2.5(-2.7) cm long, 1.8-3 cm wide, surface in mature specimens smooth; calyx persistent at fruit apex, the tube to 0.5-0.7 cm long, 0.5-0.6 cm wide at the mouth, with low keels from its mouth to the base, not extending downward to the fruit proper, forming apical spurs projecting 0.5-1 mm beyond the calyx margin; when ripe splitting irregularly to expose dark coloured seeds embedded in a bright yellow-orange pulp. **Seeds** many, irregularly angular-elliptic, flattened.

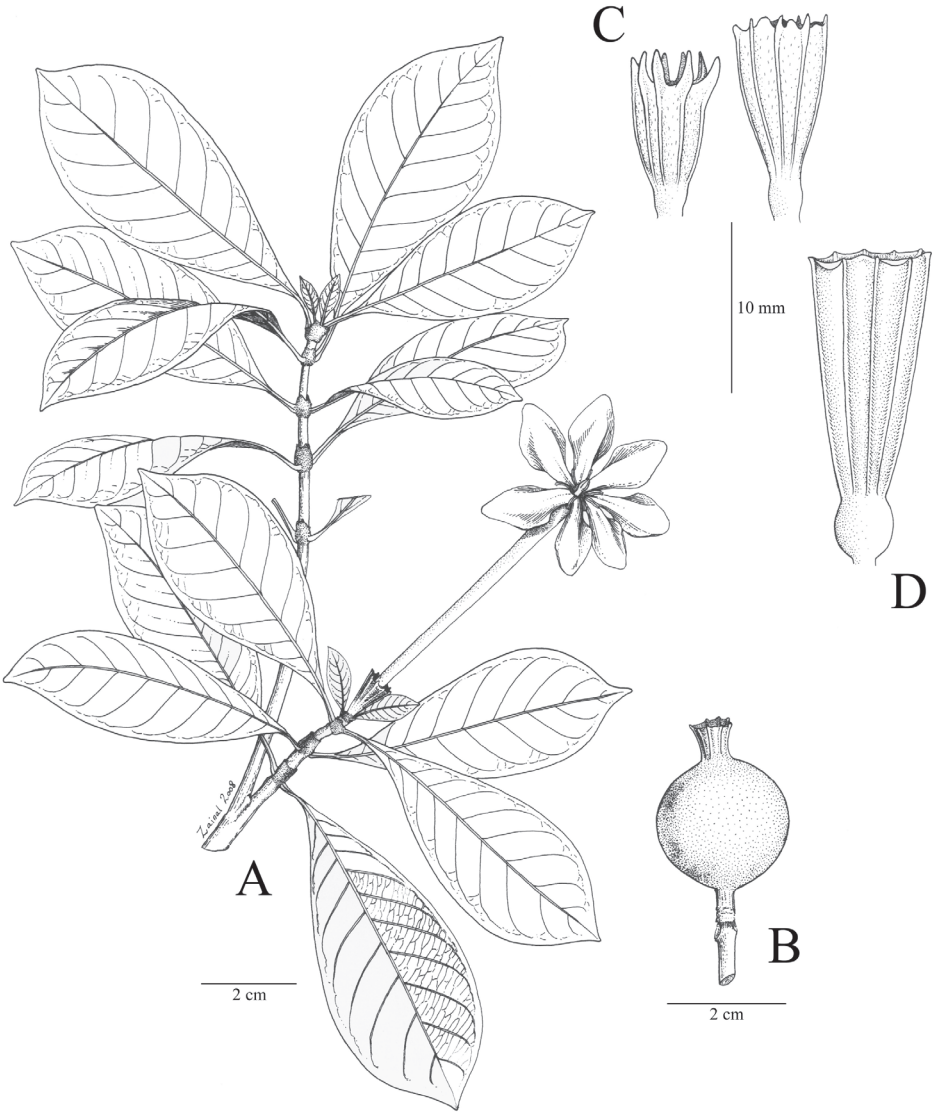

Figure 4. *Gardenia subcarinata.* A-C. *Gardenia subcarinata* var. *subcarinata*: A. Leafy branches, one terminated by a solitary flower; B. Fruit with persistent calyx; C. Calyx with protruding apical keels of the less common (left) and the more common condition (right). D. *Gardenia subcarinata* var. *sumatrana*, calyx without protruding apical keels. [A from *T. & P. 389 (KL 2989)* (L); B from *Curtis 686* (SING barcode no. 0048386); C from *Ngadiman SFN 34926* (A) (left) and *Zahir KEP 99132* (A) (right); D from *Rahmat 1727* (A)].

Habitat and ecology: Lowland forest (sea level to about 1750 ft [533 m]).

Distribution: Endemic to the Malay Peninsula (Fig. 5).

Proposed IUCN conservation assessment: Vulnerable due to fragmented and declining area (VU A4ac).

Note: The type material for this taxon requires clarification. Corner (1939) designated *Curtis 686* in the Singapore Herbarium, collected from Government Hill (=Penang Hill) in Penang, Peninsular Malaysia, as the type of his *G. tubifera* var. *subcarinata* (the basionym of the species). However, in the Singapore Herbarium there are six sheets with this number, but differently dated. Two of the sheets are dated February of 1889, one of which has Corner's handwriting on it, stating "Type". These are the two sheets considered to represent the type material of the species, and the sheet bearing Corner's type annotation is considered the holotype, the other regarded as an isotype sheet (see designations above). Another two sheets are dated March, 1890, from the same locality but without any annotation by Corner. The remaining two sheets are dated July, 1893, also without annotation by Corner. Quite clearly, Curtis had assembled material from three different gatherings from Government Hill and given them all his number 686. Only the two sheets dated February, 1889, are to be accepted as type material.

Specimens examined: MALAYSIA: **Peninsular Malaysia. Johor,** Bandar Tenggara, Linggiu Forest Reserve, 23 Jul 1991, *Lesmy FRI 35917*, flower (A, L, SING). **Kedah,** Bukit Enggang, Bukit Enggang Forest Reserve, 4 Dec 1969, *Everett FRI 13766*, fruit (L), fruits (A); Pedu, road from Pedu to Belatik, 15 May 1995, *Zainudin & Bedul Moh 5541*, flowers (L). **Pahang,** Raub, Sungai Sempam, 15 Apr 1970, *Soepadmo 666*, fruit (BO, KUL); Taman Negara, path to Terangan hide, 1 Apr 1975, *Chan FRI 23851*, flower (A, L, SING); Taman Negara, trail from Terenggan to Kumbang Salt Lick, 1 May 1975, *Balgooy 2603*, flower (NY), flowers (L); Ulu Krau, Gunung Benom Game Reserve, 22 Apr 1967, *Zahir KEP 99132*, flower (A). **Penang,** without locality, Mar 1881, *King's collector 1474*, flower (L); Government Hill, Feb 1889, *Curtis 686*, flowers & fruit (SING [sheet nos. 0048397 and 0048383]); ibid., Mar 1890, *Curtis 686*, flowers & fruits (SING [sheet nos. 0048386 and 0048520]); ibid., Jul 1893, *Curtis 686*, flowers (SING [sheet nos. 0048524 and 0048394]); Telok Bahang, Pantai Acheh Forest Reserve, 15 Sep 1966, *Chelliah KEP 98143*, fruits (A); Tiger Hill, 18 Nov 1950, *Sinclair SFN 39095*, flowers & fruit (L, SING); ibid., 18 Nov 1950, *Sinclair 6705*, fruit (US). **Perak,** Sungai Kerian Estate, 29 May 1938, *Spare SFN 34574*, fruits (A); Taiping, 30 Oct

1969, *Everett FRI 13596*, fruits (A), Taiping, Maxwell Hill, 27 Feb 1983, *Khairuddin FRI 31835*, flower & fruit (A); Maxwell Hill road, 30 Oct 1969, *Kochummen FRI 2919*, fruit (A). **Selangor,** Kanching Forest Reserve, 25 Oct 1979, *Kochummen FRI 11496*, flower & fruit (A); Kuala Selangor, Sungai Tinggi, 18 Oct 1937, *Md Nur 34129*, flower & fruits (A), fruit (L); Kuala Lumpur to Kuala Selangor, 27 May 1971, *T. & P. 389 (KL2989)*, flowers (L, SING). **Terengganu,** Dungun, Bukit Bauk Forest Reserve, 19 Nov 1978, *Chan FRI 25155*, fruit (A), Bukit Bauk, 27 May 1986, *T. & P. 1017 (KL 3517)*, fruit (L); ibid., 25 Jul 2006, *Low et al. LYW 131*, leafy branch (KLU). SINGAPORE: Garden Jungle, 9 Dec 1889, *Ridley 2588*, flowers (SING); Bukit Timah, 4 Apr 1938, *Ngadiman SFN 34926*, flowers (A, L).

2a. ***Gardenia subcarinata*** var. ***sumatrana*** Y.W.Low, *var. nov.*
A var. typica carinis calycis non extentis supra apicem tubus calycis differt. – **Typus:** North Sumatra, Bila, Estate Aek-Buro, 15 Oct 1928, *Lörzing 14218* (holo, SING; isotypi, A, L). **Fig. 4D.**

Habitat and ecology: Lowland forest (sea level to about 3281 ft [1000 m]).

Distribution: Endemic to Sumatra (Fig. 5).

Proposed IUCN conservation assessment: Vulnerable due to very few known, small or restricted populations (VU D2).

Note: This is recorded as a tree reaching about 20 m high. It shares much similarity with the typical variety, differing only in the keels on the flower calyx tube, which do not expand into spur-like projections apically. In contrast, in *G. subcarinata* var. *subcarinata*, the keels on the calyx tube form conspicuous spur-like expansions at their apex.

Specimens examined: INDONESIA: **Sumatra,** East Coast Sumatra, vicinity of Rantau Parapat, Bila, 28 Mar-10 May 1932, *Rahmat Si Toroes 1727*, flower (A, NY, US); North Sumatra, Bila, Estate Aek-Buro, 15 Oct 1928, *Lorzing 14218*, flowers (A, SING), flowers & fruit (L); North Sumatra, Sibolangit, 1-4 Apr 1918, *Bruinier 4*, flowers (L); Baven Bandarbarat, 11 Aug 1918, *Lorzing 5914*, flowers (L); Palembang, Banjoeasin, 16 Nov 1915, *Grashoff 826*, flowers (L).

3. ***Gardenia tubifera*** Wall. ex Roxb.
Fl. Ind. ed. Carey & Wall. 2 (1824) 562 – **Type:** Singapore, Oct 1822, *Wallich Catalogue no. 8266*, (holo, K-W; isotypes, K, sheets no. K000173277 & K000173278). **Fig. 6.**

Figure 5. Distribution of *Gardenia subcarinata* var. *subcarinata* and *G. subcarinata var. sumatrana* in West Sundaland area.

-*Gardenia tubifera* "form 1" & "form 3" sensu King & Gamble, J. Asiat. Soc. Beng. 72 (2) (1903) 219, *non* "form 2" (= *G. subcarinata*).
-*Gardenia tubifera* sensu Corner, *pro parte*, Gard. Bull. Straits Settlem. 10 (1939) 46, Wayside Trees of Malaya 1 (1952) 541, excl. *G. speciosa* Hook.f. & *G. elata* Ridl.
-*Gardenia resinifera* Korth., Ned. Kruidk. Arch. 2 (1851) 191, *nom. illeg., non Gardenia resinifera* Roth, Nov. Pl. Sp. (1821) 150, *nec Gardenia resinifera sensu* Ridley, Fl. Malay Penin. 2 (1923) 83. – Type: Borneo, *Korthals* s.n. (syntype, L, 4 sheets).
-*Gardenia glutinosa* Teijsm. & Binn., Cat. Hort. Bot. Bogor. (1866) 119, *nom. invalid.*

Tree to *ca* 13 m high, trunk to *ca* 46 cm diameter, not buttressed. **Bark** smooth, light grey-brown to dark brown. **Stipules** connate into a cylindrical tube, 0.4-0.7 cm long, apex 2-lobed to subtruncate, outside puberulent and generally coated with resin (this sloughing off in older material), inside with a mixture of dark-coloured colleters and scattered fine translucent trichomes densely covering the basal half (trichomes longer than the colleters) and glabrous in the upper half. Petiole 0.2-1.5 cm long, 1-1.3 mm thick, subglabrous to evenly covered with puberulent hairs, sometimes conspicuously resin-coated. **Leaf** lamina obovate; 4.5-12.5(-21) cm long, 2.3-5.6(-6.3) cm wide; leaf base cuneate; leaf apex cuspidate to rarely rounded; thinly coriaceous; conspicuously coated with resin when young; midrib flat to sunken and glabrous on upper side, prominent and glabrous to very rarely sparsely, minutely puberulent on lower side; secondary veins 9-15(-17) pairs, flat and glabrous on upper side, prominent and glabrous to minutely puberulent on lower side, vein axils on the lower side with hairy pocket domatia; tertiary venation scalariform. **Flowers** solitary. Pedicel 0.2-0.5 cm long and 1-2 mm thick in open flowers, reaching 0.2-1.5 cm long and 1.5-4 mm thick at fruit maturity. **Calyx** narrowly obconical to somewhat spindle-shaped, the apex often slightly oblique and torn into two acute portions with corolla emergence, the tube subsequently slightly flared outward and often appearing subtruncate in the open flower; medium green, 0.6-1.5(-1.9) cm long, 2-4 mm wide at the base, becoming 5-8 mm wide at the apex; outside densely puberulent at the base and sparsely puberulent to subglabrous in the upper part, often coated with resin; inside glabrous for most of the upper part to about 0.5 cm from the tube margin, densely covered with a mixture of dark-coloured colleters and translucent trichomes at the basal half (trichomes longer than colleters and especially conspicuous as a dense fringe at the very base of the calyx), without lobes, surface smooth, without keels but rarely (upon drying) with a few faintly visible longitudinal ribs (probably the main vascular traces). Corolla hypocrateriform, cream turning light yellow, then deep to orange yellow; tube (2.4-)3.9-9.4 cm long, 1.5-3 mm wide at the mid-portion, 5-9 mm wide at the throat, outside glabrous, inside largely glabrous except for narrow patches of sparse ribbon-like translucent hairs from the throat to just below the anthers; lobes 6-9, oblanceolate to obovate, 14-29 mm long, 7-18 mm wide, contorted to the left in the bud stage, glabrous on both sides. Stamens 6-9, inserted just below the corolla throat and between corolla lobes, dorsifixed; filaments very short to inconspicuous; anthers 6-8 mm long, *ca* a third to half of its length exserted; pollen in tetrads. Style (2.5-)4.3-9.7 cm long, glabrous; stigma club-like with 4-5 lobes initially cohering together, (3-)5-7 mm long, 2-4 mm wide, wholly exserted; ovary with several parietal placentas. **Fruits** subglobose, 2.3-3.3 cm long, 2.4-3 cm wide, surface in mature specimens smooth; calyx persistent at fruit apex, the tube to 0.5-

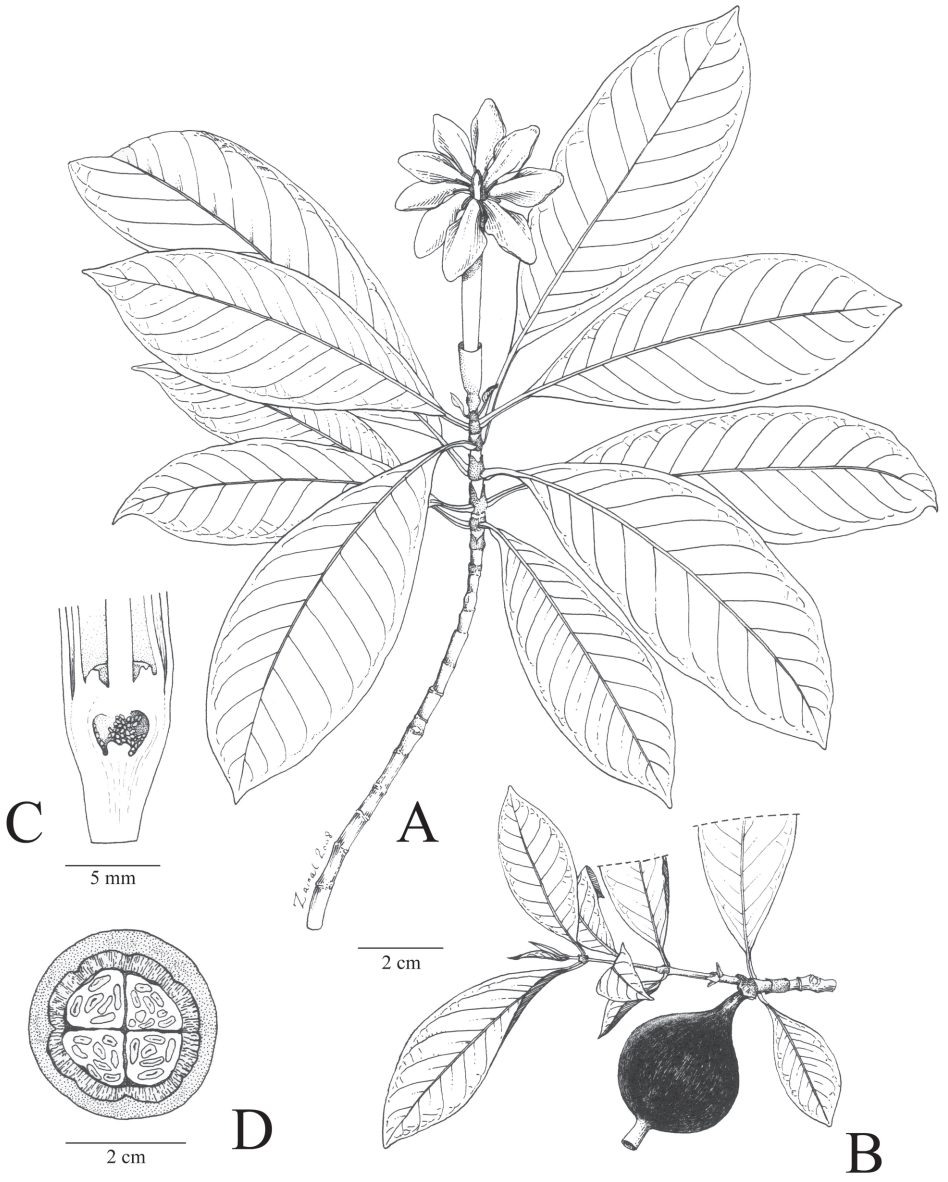

Figure 6. *Gardenia tubifera.* A. Flowering leafy branch; B. Leafy branch with fruit; C. Longitudinal section through lower part of flower including hypanthium; D. Transverse section of fruit. [A from Low *LYW 228*; B from *Low & Zulkapli LYW 163*; C & D from *Low et al. LYW 35* (all KLU)].

1.4 cm long, 0.6-0.8 cm wide at the mouth; when ripe splitting irregularly to expose dark-coloured seeds embedded in a bright yellow-orange pulp. **Seeds** many, irregularly angular-elliptic, flattened, 4-5 mm long, 4-6 mm wide, testa surface fine-areolate.

Habitat and ecology: Confined to coastal estuarine and swamp forest.

Distribution: Widespread from Thailand (Chonburi, Kao Sabab and Peninsular Thailand), Malay Peninsula, Sumatra to Borneo (Kalimantan only) (Fig. 7).

Proposed IUCN conservation assessment: Vulnerable due to fragmented and declining area (VU A4ac).

Note: In the Kew Herbarium, the type material *Wallich Catalogue no. 8266* is represented on three sheets. The first sheet, from Wallich's Herbarium (K-W: a fruiting specimen from Singapore) is not barcoded, but represents the holotype, in accordance with Recommendation 9A.4 of the International Code of Botanical Nomenclature (Vienna Code) (McNeill *et al*. 2006). The second sheet, incorporated from Hooker's Herbarium and bearing Kew barcode K000173277 (also a fruiting specimen), is an isotype. The third sheet contains two different collections; the specimen on the lower half of the sheet (a fruiting specimen) is a duplicate of *Wallich Catalogue no. 8266*, barcoded K000173278, and also represents an isotype, whereas the specimen on the upper half of the sheet is Hervey's collection of 1886 (including a fruit and a flower) and is not a part of the type material.

Specimens examined: INDONESIA: **Kalimantan. Central Borneo,** Kec. Mentaya Hilir Utara Sei Sampit, Bagendang, 25 Feb 1982, *Afriastini 341*, flower (L); Kumai, Sungai Bekunyir, 14 Mar 1975, *Anderson (1975)2*, flowers & fruit (BO 2 sheets); **East Borneo,** Pesiangan Bengka and Muara Kaman, Mahakam river, 24 Aug 2000, *Adriansyah AA 3002*, fruit (A, K); Samarinda, Sungai Pedang Kota Bangun Ulu, 23 Feb 1992, *Ambri & Arifin AA 443*, fruit (A, K); **South Borneo,** Bangarmassing, 1857-1858, *Motley 341*, flowers (K); Maharanda, 1918, *Anon. 15b*, flowers (BO); Pleihari, 22 Aug 1965, *Sauveur 965*, flowers (L); Poeloe Lampei, sine date, *Korthals* s.n., fruits (L); ibid., sine date, *Korthals 2415*, leafy branch (L); ibid., sine date, *Korthals 2416*, leafy branch (L); ibid., sine date, *Korthals 2417*, leafy branch (L); Rantau to Maugasari, 14 Dec 1988, *Giesen 70*, fruit (L), fruits (L); Tanah Laut District, Hutan Kintap base camp, 20 Apr 1985, *Leeuwenberg & Rudjiman 13460*, flowers & fruit (L); Z. O. Borneo (Southeast Borneo), Veenbosch bij Tamban, 10 Oct 1939, *Polak 480*, fruit (A, BO, L, SING); **West Borneo,**

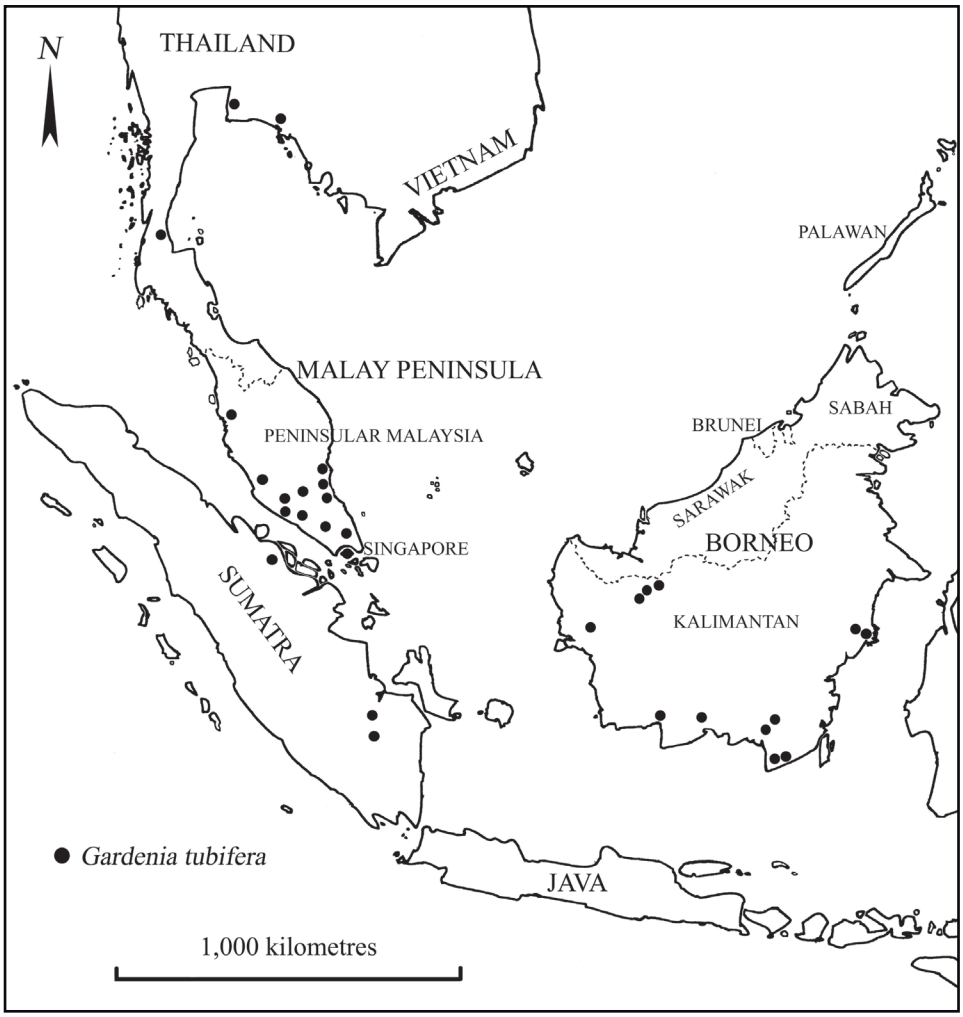

Figure 7. Distribution of *Gardenia tubifera* in the Sundaland area.

Kenepai, sine date, *Teysmann 8332*, fruits (L); Lake Tajan, 22 Oct 1949, *Main 1746*, immature fruit (A, K) fruit (BO); Salimbauw, sine date, *Hallier B 1257*, flowers (L 2 sheets) flower & fruit (L); Soeka Lanting, sine date, *Hallier B 183*, fruit (L); Soengai Kenepai, sine date, *Hallier B 1906,* fruit (L); Sungei Batang Putus, South of Danau Sentarum Wildlife Reserve, 31 Mar 1986, *Giesen 1*, flowers (L) flower & fruit (L); West Koetai, No. 3 near Kampong Sabentoeloeng, 20 Jun 1925, *Endert 1518*, fruits (L 2 sheets), flower & fruit (A, BO, SING). **Sumatra,** Palembang, Sematang, 19 Jan 1920, *Endert E 808*, flowers (L); Palembang, Kajoeagoeng, 29 Mar 1928, *de Voogd 139*, flowers (L 2 sheets); ibid., 23 Jan 1929, *de Voogd 283*, flower (BO); Upper Riau, Pekanbaru, Tenajan Reserve, 11 Aug 1960, *Soepadmo 20*, fruit (K, SING).

MALAYSIA: **Peninsular Malaysia.** without locality, 1862-1863, *Griffith KD 2816*, flower (L), flowers (K). **Johor,** Bekok River, 1880, *Ridley 11139*, flower & fruit (SING); Kluang, 5 Mar 1973, *Hardial Singh & Samsuri HS 1092*, fruit (US), flower & fruit (A); Kota Tinggi, Dec 1892, *Ridley 4209*, flower & fruit (SING), Kota Tinggi, Sungai Bang, 13 Mar 1966, *Sinclair 10863*, flower (A, SING); Kuala Sembrong, 1892, *Lake & Kelsall 4088*, flowers & fruit (SING); Sungai Sedili, Bagan Limau, 18 Feb 1931, *Corner SFN 24625*, flower & fruit (SING), Sungai Sedili, Danau, 27 Mar 1932, *Corner SFN 25971*, flower & fruits (BO, SING). **Kuala Lumpur,** University of Malaya, Rimba Ilmu Botanic Garden, cultivated opposite the medicinal plants section near the front entrance, 24 Dec 2008, *Low LYW 228*, flower (KLU). **Melaka,** without locality, sine date, Anon. s.n., flower (SING), 1845, *Griffith* s.n., flowers & fruit (K, NY), Aug 1886, *Hervey* s.n., flower & fruit (K), sine date, *Lobb 347*, flowers (K), 1871, *Maingay KD 838*, flowers & fruit (K 2 sheets, L), 1871, *Wright* s.n., flowers (K); Bt. Sadanau, Feb 1890, *Derry* 360, flowers & fruit (SING); Merlimau, Jun 1889, *Derry 199*, fruits (SING); Sungai Tebong, South of Bukit Putus, 30 Jan 1916, *Burkill SFN* 1434, flower (SING); 5 miles South of Malacca, Batu Berendam Road, 29 Apr 1961, *Burkill HMB 2640*, fruits (A, SING). **Negeri Sembilan,** 12 miles Simpang Pertang-Kuala Pilah roadside, 2 Sept 1977, *Asri FRI 25738*, fruit (A). **Pahang,** Lubuk Paku, 28 Nov 1924, *Ngadiman SFN 16114*, flower & fruits (SING); Muazam Shah to Menchali Road, road to Kampung Sedaik Asal, 1 May 2008, *Low et al. LYW 167*, fruit (KLU); Pekan, 28 Nov 1929, *Burkill & Haniff SFN 17129*, flowers (A), flowers & fruit (SING); ibid., 20 Aug 1909, *Ridley* s.n., flower (SING); ibid., May 1890, *Ridley 1375*, flower (BO), flowers (BO, SING); Pekan, Nenasi Forest Reserve, 17 Apr 2004, *Ong EL 36*, flower & fruits (KLU 2 sheets); Pekan, Sungai Bebar, 10 Apr 2005, *Low et al. LYW* 35, flower & fruit (KLU); ibid., 30 Oct 2007, *Low & Zulkapli LYW 163*, fruit (KLU); Rompin, Menchali Forest Reserve, 1 May 2008, *Low et al. LYW 169*, fruit (KLU); Tasek Bera, 24 Apr 1980, *Gianno 370*, flower & fruit (KLU); ibid., 7 Sept 2005, *Low et al. LYW 70*, fruits (KLU); ibid., 10 Nov 1975, *Stone et al. 12264*, flower (KLU), flowers (KLU), fruit (NY); Tasek Bera, Kota Iskandar, 1 Feb 1962, *Anon. 1061*, flowers & fruit (KLU); Tasek Bera, near Sungai Bera, 15 Oct 1930, *Henderson SFN 24126*, fruit (NY). **Perak,** Sungai Kerian Estate, 29 May 1938, *Spare SFN 34574*, fruits (SING). **Perlis,** Kangar, Jalan Batu Pahat (cultivated?), 22 Aug 1991, *Zainudin et al. AZ 3825*, fruit (L), leafy branch (K). **Selangor,** Petaling Jaya, Section 16, cultivated inside a bungalow compound (private property), 3 Mar 2006, *Low et al. LYW 164*, flowers (KLU); Sungei Buloh Reserve, Kuala Lumpur, 3 Mar 1923, *Foxworthy 7960*, flowers (SING). SINGAPORE: without locality, sine date, *Burkill 324*, fruits (US), Oct 1822, *Wallich Catalogue no. 8266*, fruit (K 2 sheets, K-W). THAILAND: Chonburi, Sriracha, 4 Feb 1927, *Collins 1407*, fruits (US); ibid., 7 Dec 1927,

Collins 1833, flower (US 2 sheets); Kao Sabab, 18 Jan 1958, *Sorensen et al. 506*, fruit (BKF, L); Peninsular Thailand, Chumpon, Langsuan, 10 Jan 1977, *Santisuk 908*, fruit (A); Satul, Kuan La Long, 30 Jan 1961, *Ploenchitr 1602*, flower (BKF).

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