

## A new and substrate specific species of *Ilex* (Aquifoliaceae) from north-eastern Queensland, Australia

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### Abstract

*Ilex corymbosa* A.J.Ford & Halford is formally described and illustrated, with notes on habitat, distribution, conservation status and how to distinguish it from *I. arnhemensis*, the only other native species of *Ilex* in Australia.

### Introduction

*Ilex* L. is the sole genus within Aquifoliaceae and it is estimated to include more than 664 species of dioecious trees and shrubs (Yao *et al.* 2020). The genus is widely distributed throughout the tropics and temperate zones, with centres of species diversity in east Asia and the tropical Americas (Stevens 2001; Xu *et al.* 2017; Yao *et al.* 2020).

In Australia, *Ilex* is represented by two species (Pedley 1984). The one named species, *Ilex arnhemensis* (F.Muell.) Loes., has two geographically separated subspecies which both predominantly inhabit riparian rainforest vegetation in northern Australia. The other species listed by Pedley (1984) is an undescribed species of *Ilex* from north-east Queensland. This species has been represented in Australian herbaria for more than 50 years and was first alluded to in the card key to the rainforest trees of north Queensland (Hyland 1971). Until recently only mature male flowers and a few immature fruit were known, even though it occurs in multiple locations. Female flowers and mature fruits have recently been collected, enabling a full description to be made and we describe this species below as *I. corymbosa* A.J.Ford & Halford.

### Material and Methods

This study of *Ilex* was based on the examination of herbarium specimens held at BRI and CNS. These specimens also include the valuable spirit (alcohol) preserved collection at CNS. In addition, fieldwork by the first author enabled the collection of fresh material (both male and female) for morphological assessment as well as pertinent ecological information.

## Taxonomy

*Ilex corymbosa* A.J.Ford & Halford, *sp. nov.*

Type: Queensland: Cook District: Tam O'Shanter Forest Reserve, off Lacey Creek walking track towards Licuala, NW of Mission Beach, 28 Aug 2019, A. Ford 6746 & W. Cooper (holotype: BRI; isotypes: CNS 149564.1, CNS 149564.2, *distribuendi*).

*Ilex* sp. Gadgarra (B.P.Hyland RFK2011) [Hyland *et al.*, 2010].

*Ilex* sp. (Gadgarra B.P.Hyland RFK2011) [Jessup 1994, p.23; Jessup & Halford 2020.

*Ilex* sp. (Gadgarra) [Cooper 2004, p. 58].

*Ilex* sp. [Pedley 1984, p. 202].

*Ilex* sp. [Hyland 1971].

Illustrations: Cooper (2004: 58), as *Ilex* sp. (Gadgarra).

Evergreen dioecious trees to 30 m high with diameter at breast height up to 60 cm; trunk terete to fluted usually buttressed at base; bark flaky to fissured or lacking any distinguishing features. Young leafy branchlets purplish, terete to angled, longitudinally striated, clothed in moderately dense, very short whitish antrorse hairs (*c.* 0.1 mm long). Adult branchlets and branches creamy-grey, usually with conspicuous globose and whitish lenticels. Stipules (moderately persistent) triangular, 0.1–1 mm long, inconspicuous. *Leaves* alternate, petiolate; petiole 4–8 mm long, channelled adaxially, longitudinally striated abaxially, purplish when young and ageing to green; lamina chartaceous, elliptic to elliptic-obovate, 5.8–11.5 cm long, 2.1–4.3 cm wide, length to width ratio 2.1–3:1, glabrous; base attenuate; margin entire (see notes for juvenile leaf description); apex acute to acute-acuminate, with or without a distinctive mucro *c.* 0.4 mm long; midvein in fresh and dried material impressed adaxially (rarely flush), prominently raised abaxially (more so proximally); secondary veins 8–12 on each side of the midvein, brochidodromous, flush to slightly impressed adaxially and raised abaxially in fresh material, raised on both surfaces when dried; tertiary venation scarcely discernible when fresh or dried. Inflorescences fasciculate consisting of cymes or solitary flowering units in leaf axils of one-year old growth, rarely ramiflorous or on new growth. *Male inflorescence* with 7–14 cymes; cymes 1–3-flowered, peduncles 1.1–9 mm long; rachis 1–4 mm long; bracts basal, *c.* 1.1 mm long, deltoid, puberulent; subtending flower bract 0.4–0.5 mm long, triangular, glabrous to sparsely puberulent; sub-basal bracteoles when present *c.* 0.5 mm long; pedicels 1.9–3.6 mm long, *c.* 0.4 mm diameter, puberulent, sparsely clothed in very short arching antrorse hairs. *Flowers* actinomorphic, 7–8 mm diameter at anthesis. *Calyx* 4–6-lobed (occasionally with vestigial or poorly formed lobes when 4-lobed), green; calyx tube much shorter than the lobes; lobes ovate, 0.7–1.1 mm long, 0.6–1.1 mm wide, glabrous on both surfaces, margin ciliate. *Corolla* whitish, shortly connate basally; tube *c.* 0.5 mm long; lobes 4–6, imbricate, spreading at anthesis, broadly oblong-elliptic, boat-shaped, 1.9–2.9 mm long, 1.5–2.5 mm wide, glabrous on both surfaces, margin shortly ciliate. *Stamens* 4–6, inserted at corolla lobe sinuses; filaments 0.8–1.9 mm long, glabrous; anthers ovate 1–1.4 mm long, *c.* 0.8 mm wide, dehiscing laterally through longitudinal slits. *Rudimentary ovary* ovoid, glandular-papillose, apex beaked. *Female inflorescence* 1–8-flowered, peduncles *c.* 1.1 mm long; rachis 1–2 mm long; pedicels *c.* 5.2 mm long, *c.* 1 mm diameter, puberulent with short, antrorse hairs; bracts *c.* 1 mm long, sub-basal bracteoles *c.* 1 mm long. *Flowers* actinomorphic, 8–9 mm diameter. *Calyx* 4–6-lobed, calyx tube much shorter than the lobes; lobes broadly ovate, 0.8–0.9 mm long, 1.1–1.4 mm wide, sparsely puberulent abaxially, margin ciliate, green. *Corolla* whitish, shortly connate basally; tube *c.* 0.3 mm long; lobes 4–6, imbricate, spreading at anthesis, broadly oblong-elliptic, boat-shaped, 3–3.5 mm long, 2.7–2.9 mm wide, glabrous on both surfaces, margin shortly ciliate. *Staminodes* 4–6, inserted at corolla lobe sinuses; filaments *c.* 1.5 mm long, glabrous; sterile anthers *c.* 0.5 mm long. *Ovary* shortly ellipsoid, glabrous, 4–6-locular, each locule with one distally inserted ovule, *c.* 1.7 mm high, *c.* 1.8 mm diameter; stigma sessile, mammilliform-turbinate, sticky. *Fruit* a drupe, fleshy, globose to depressed globular (sometimes laterally compressed), 6–7 mm long, 7–8.5 mm diameter, glabrous, red when ripe (changing from yellow-orange), calyx persistent, apex crowned by 4–6 persistent stigmas; pyrenes 4–6, 1-locular, creamy yellow, 5–6 mm long, endocarp thick and bony, abaxial surface longitudinally 3–5-grooved. *Seed* curved, 3-faced, 4–5 mm long, outer testa completely covered with densely packed wavy striations, inner testa thin and brown, endosperm starchy. *Embryo* *c.* 0.4 mm long, radicle about the same length as the cotyledons. Specific wood density 587 kg/m<sup>3</sup>. *White Sassafras*. (Figure 1)



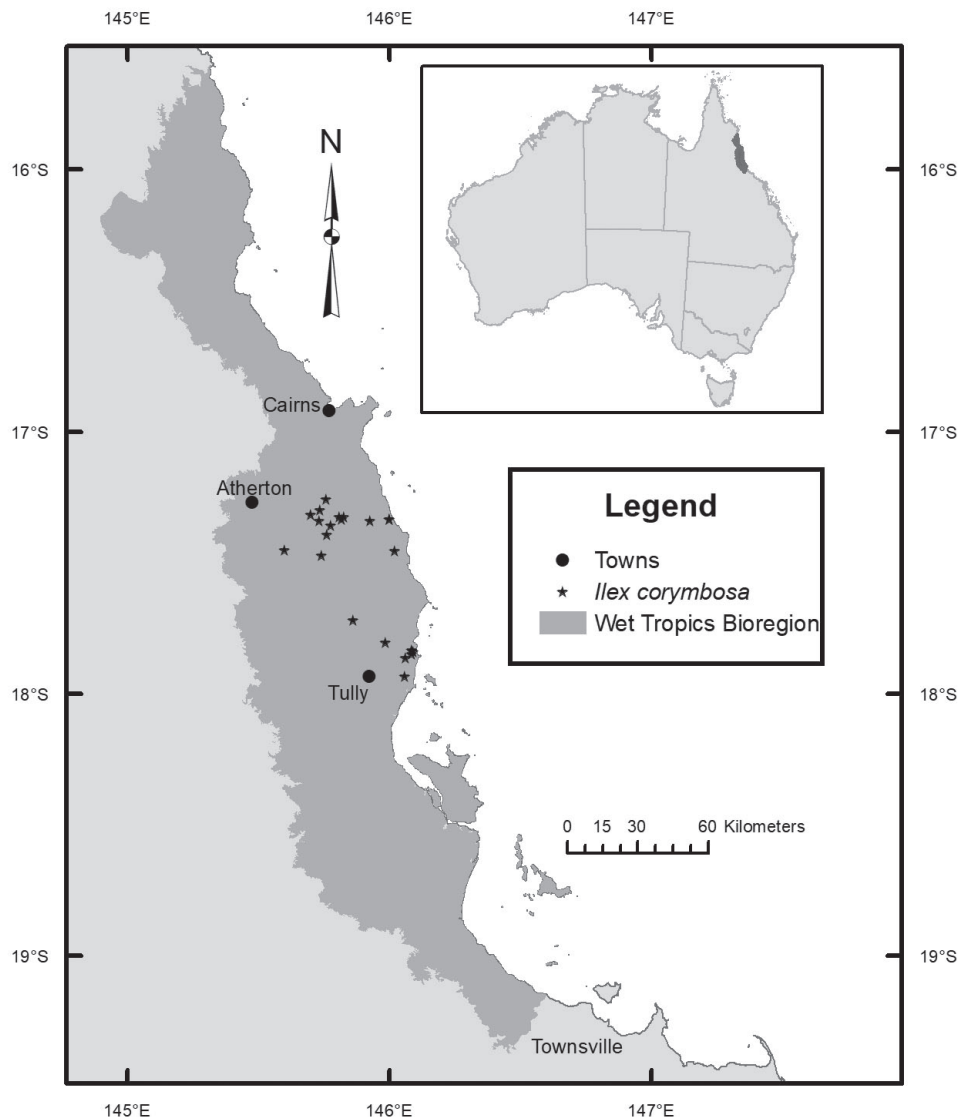
**Fig. 1.** *Ilex corymbosa*. A. Male inflorescence habit and showing purple petioles on new growth. B. Male inflorescence habit on one year old twigs. C. Ramiflorous male inflorescence and showing white lenticels on three year old branchlets. D. Female inflorescence habit. E. Mature fruit. F. Trunk from a canopy tree 30 cm dbh. (Photo credits; A: Rigel Jensen; E: Wendy Cooper; B, C, D and F: Andrew Ford).

**Diagnosis:** *Ilex corymbosa* differs from *Ilex arnhemensis* by having: puberulent leafy twigs (*vs* glabrous), shorter corolla lobes in male flowers (1.9–2.9 *vs* 3.2–4 mm long), shorter filaments in male flowers (0.8–1.9 *vs* c. 2.5 mm long), staminodes present in female flowers (*vs* absent), corolla well-formed in female flowers (*vs* vestigial), inflorescences fasciculate (*vs* non-fasciculate), fruit red (*vs* green-cream) and fewer number of pyrenes per fruit (4–6 *vs* 12–16).

**Distribution:** Endemic to the Wet Tropics bioregion (Department of Environment 2012) in north-eastern Queensland, Australia, where it is currently known from a restricted area between the eastern edge of the Atherton Tableland (near Malanda) and Mission Beach (east of Tully) (Figure 2).

**Habitat and Ecology:** This species is recorded from the lowlands and coastal foothills to sub-mountainous areas in very high rainfall (> 3,000 mm per annum) locations within mesophyll to notophyll rainforests on heavy clay soils derived exclusively from metamorphic substrates. Types of metamorphic rocks include: schist, quartzite and mudstones. Common canopy species throughout most of its range include: *Balanops australiana*, *Beilschmiedia bancroftii*, *Beilschmiedia oligandra*, *Cardwellia sublimis*, *Carnarvonia araliifolia*, *Ceratopetalum virchowii*, *Cryptocarya oblata*, *Endiandra montana*, *Flindersia* spp., *Garcinia zichii*, *Musgravea heterophylla*, *Musgravea stenostachya*, *Monoon patinatum*, *Syzygium endophloium* and *Syzygium kuranda*. Common small trees and shrubs include: *Acronychia vestita*, *Antirhea tenuiflora*, *Apodytes brachystylis*, *Atractocarpus* spp., *Chionanthus axillaris*, *Citronella smythii*, *Gossia myrsinocarpa*, *Pilidiostigma tropicum*, *Steganthera laxiflora*, *Psychotria* spp. and *Toechima erythrocarpum*. Altitudinal range from near sea-level to 840 m.

**Phenology:** This species has been very sparingly collected when fertile, with most specimens being sterile. Flowering material is recorded for August–September and mature fruit is known from November.



**Fig. 2.** Distribution of *Ilex corymbosa* in north-east Queensland, Australia.

**Conservation status:** *Ilex corymbosa* is yet to be evaluated against the International Union for the Conservation of Nature criteria (IUCN 2019). The species has an estimated extent of occurrence of only 1620 km<sup>2</sup>. There is limited evidence to support a decline in population even though the quality of the habitat has been dramatically compromised by severe cyclonic activity in the past 15 years. Further fieldwork is required to assess recruitment activity, population numbers and any threats to the species.

**Etymology:** The specific epithet is derived from the Latin *corymbosus* and alludes to the clustered flowers and fruits of this species.

**Affinities:** At a gross morphological level *Ilex corymbosa* would appear to be most closely related to the other Australian species, *I. arnhemensis*. A comparison of diagnostic differences between the two native species in Australia is provided in Table 1. However, sexual dimorphism is extreme with *I. arnhemensis* having a vestigial and caducous corolla in pistillate flowers which seemingly perform no function as they do not enclose the ovary even when the buds are primordial. Pistillate flowers of *I. corymbosa* on the other hand are well-formed with an enclosing corolla and staminodes which exhibit cryptic dioecy (Eckhart 1999).

Sexual dimorphism is strongly exhibited in the two Australian species of *Ilex*, with the inflorescence types being strictly sexually differentiated between and within both species. *Ilex arnhemensis* has a solitary (sensu Hu 1949) inflorescence structure with males usually having a dichotomous compound cyme or a 3-flowered simple cyme to a long-pedicellate solitary flower. Female inflorescences are either a 3-flowered simple cyme or a short-pedicellate solitary flower. *Ilex corymbosa* has a fasciculate (sensu Hu 1949) inflorescence structure with males having many 1–3-flowered individual branches, whereas females occur in 1-flowered individual branches only.

To date there are two published *Ilex* phylogenetic studies, both using plastid and nuclear markers to infer relationships (Manen *et al.* 2010 and Yao *et al.* 2020). The data presented by Manen *et al.* (2010) (figures 3 and 4 pages 963 to 964) included the two Australian species and placed them in the “Indico-malaicae alliance”, which includes species from South-East Asia and New Caledonia. The two Australian species were not found to be sister species and *I. arnhemensis* was inferred to be more closely related to *I. wallichii* Hook.f., a species that occurs in Indo-China to Peninsula Malaysia (Manen *et al.* 2010). The evolutionary relationships of *I. corymbosa* with the other species in the Indico-malaicae alliance was not resolved with the work of Manen *et al.* (2010) and it was not included in the dated phylogeny of Yao *et al.* (2020). The fossil calibrated molecular dates indicated that *I. arnhemensis* derived post-Miocene from within a largely South-East Asian clade of species with entire leaf margins (Yao *et al.* 2020). While the fossil pollen records suggest that *Ilex* was once widespread in Australia during the upper Cretaceous to late Miocene (Martin 1977) the current molecular data do not suggest that either of the Australian species are ancient relicts but more likely originated from more recent independent introductions from Sunda. While the molecular phylogenies are not fully resolved both the nuclear and plastid markers suggest multiple movements of *Ilex* into South-East Asia, all likely from within Eastern Asia. Further work is needed to understand the species level relationships of *I. corymbosa* within the South-East Asian clade and this will require sampling across this region, enabling further understanding of the floristic exchange between Sunda and Sahul.

**Table 1. Morphological comparison between *Ilex corymbosa* and *I. arnhemensis*.**

	<i>I. corymbosa</i>	<i>I. arnhemensis</i>
Leafy twig indumentum	puberulent	glabrous
Male flower corolla lobe length (mm)	1.9–2.9	3.2–4
Filament length (mm)	0.8–1.9	c. 2.5
Female flower corolla	well-formed	vestigial
Female flower staminodes	present	absent
Inflorescence	fasciculate	non-fasciculate
Fruit colour at maturity	red	green to cream
Pyrenes/fruit	4–6	12–16
Pyrene ornamentation	3–5-grooved	1-grooved
Pyrene length (mm)	5–6	c. 2.3

**Notes:** Freshly expanding new growth and current leaves have petioles and leafy twigs which are purplish. This feature is lost upon drying. Older leaves and leafy twigs also lose this purple colouration. Newly expanding leaves are pale green.

Seedling and sapling leaves of *Ilex corymbosa* have infrequent teeth [Ford *et al.* 2966 (CNS) and Ford *et al.* 3616 (CNS)]. In the field the combination of toothed leaves and purplish petioles makes this species a candidate for one of the many co-occurring species of *Symplocos*. However, *Ilex* has stipules and chartaceous leaves whereas *Symplocos* lack stipules and their leaves are coriaceous. The seedling leaves of *Ilex arnhemensis* subsp. *arnhemensis* (Hyland 25157RFK; CNS) and *I. arnhemensis* subsp. *ferdinandi* (Hyland 13437; CNS) both have toothed leaf margins.

Ripe fruit are red, but before maturity they change from yellow to yellow-orange before finally turning red.

*Ilex corymbosa* has been only recorded on metamorphic substrates, although there are extensive areas of granite, basalt and alluvium within the species range. For example, it occurs on the Seymour Range near Innisfail and then next occurs to the west on the eastern edge of the Atherton Tableland, thus, avoiding the alluvial coastal plain, the lowland to upland granites and the lowland basalts. The metamorphic rocks are from a variety of ages and origins, including units from the Hodgkinson and Barnard Provinces (Bain and Draper, 1997).

Although not mentioned, the voucher specimen that was used for *Ilex* sp. nov. (Manen *et al.* 2010, pp. 962 and 964) is referable to Ford *et al.* 2967 (CNS). This sample was sent to Lyn Craven who forwarded it to J.-F. Manen directly, without the collection details being acknowledged.

**Additional specimens seen:** QUEENSLAND: Cook District: SFR 310, Gadgarra, 3 Oct 1968, B. Hyland 2011RFK (BRI, CNS); NPR 904, Woornooran, along ‘Donkey Track’ off Russell River Track, site 29, above Chuck Lunga Creek, 4 Oct 2001, A. Ford 2967 *et al.* (BRI, CNS); Trail into *Stockwellia* site near Malanda, 4 Feb 2009, C. Costion 1699 (BRI, CNS); NPR 904 Woornooran, c. 700m S of Towalla Mine, above Coolamon Creek, site 33, 30 Oct 2001, A. Ford 3035 *et al.* (BRI, CNS); Japoon National Park, Liverpool Creek area off Warrakin Road, Japoon, 19 Dec 2007, A. Ford 5183 (BRI, CNS); Australian Insect Farm, Seymour Range, NNW of Daradgee, site 70, 10 Sep 2002, A. Ford 3616 *et al.* (BRI, CNS); Japoonvale NP, off end of Shell Pocket

Road, El Arish, 18 Oct 2006, *A. Ford* 4871 and *H. Murphy* (BRI, CNS); Dirran River, 3 Mar 2002, *R. Mazlin* 2 (CNS); SFR 1137, Mission Beach, 15 Nov 1963, *B. Hyland* 767RFK (BRI, CNS); Mission Beach, 16 Oct 1967, *B. Hyland* 1150RFK (BRI, CNS); *loc. cit.*, 16 Oct 1967, *B. Hyland* 1153RFK (BRI, CNS); *loc. cit.*, May 1968, *H.E. Volck AFO s.n.* (QRS 502867) (CNS); Wyvuri, Cape York region, 11 Jul 1974, *B. Hyland* 3060RFK (BRI, CNS); Wyvuri Holding, E of Babinda, 26 Jun 1968, *B. Hyland* 1541RFK (BRI, CNS); Tam O'Shanter Forest Reserve, off Lacey Creek walking track towards Licuala, NW of Mission Beach, 16 Nov 2019, *W. Cooper* 2610 and *T. Tuck* (CNS); *loc. cit.*, 28 Aug 2019, *A. Ford* 6745 and *W. Cooper* (BRI, CNS); North Kennedy District: Tam O'Shanter NP, low slope of Mt Douglas, off Tully-Mission Beach Road, site 151, 8 Mar 2007, *A. Ford* 4965 (BRI, CNS); Tam O'Shanter FR, along the southern Lacey Creek walking track, c. 1km from Jurs Creek crossing, west of Mission Beach, 6 May 2005, *A. Ford* 4646 (BRI, CNS).

### Key to the native species of *Ilex* in Australia

1. Leafy twigs puberulent; inflorescences fasciculate; female flowers with conspicuous corolla, staminodes present; male flowers with corolla lobes 1.9–2.9 mm long, filaments 0.8–1.9 mm long; fruit red with 4–6 pyrenes ..... ***I. corymbosa***
- 1: Leafy twigs glabrous; inflorescences non-fasciculate; female flowers with vestigial corolla, staminodes absent; male flowers with corolla lobes 3.2–4 mm long, filaments c. 2.5 mm long; fruit green to cream with 12–16 pyrenes ..... ***I. arnhemensis***

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